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A Message from the Prime Minister.

NO industry has been more severely hit by the present world depression than agriculture; indeed, the inability of agricultural communities to sell their produce profitably and therefore to buy manufactured goods in the usual quantities is one of the major causes of all our troubles. This background of world collapse does not make the solution of our own agricultural problems very easy, but the Government is fully alive not only to the economic importance of the industry, but also to the vital necessity for a prosperous and progressive countryside as a basis for a healthy, well-balanced national life.

Its policy has to be thought out in the light of two governing considerations. We must maintain the balance of the Budget, and, therefore, we cannot in this time of stringency be generous with public money; and we must also maintain the internal purchasing power of the pound, and we cannot therefore contemplate any measures which would raise appreciably the cost of living. The Government, however, has already proved conclusively its anxiety to help agriculture, and its

readiness to do all it can, subject to these limiting conditions, to help our own producers of foodstuffs to get a larger share of the home market. We shall do our best to help both farmer and farm-worker; and I would appeal to them in turn to do their best for the prosperity of their own industry. As far as the quality and quantity of production go, many of our farmers are second to none in the world; but there is obvious need for better organisation and closer co-operation on the marketing side. As a Scotsman to whom the Scottish countryside is very dear, I ask our farmers to realise how much they themselves can help to overcome their own and the country's difficulties.

21*st December* 1931.

THE MACAULAY INSTITUTE FOR SOIL RESEARCH.

W. G. Ogg, M.A., Ph.D., Director.

The beginnings of the Macaulay Institute for Soil Research may be said to date from June 1928, when Mr. T. B. Macaulay of Montreal, the president of the Sun Life Assurance Company of Canada, wrote to Sir Robert Greig inviting the co-operation of the Scottish Department for Agriculture in his schemes for the improvement of agriculture in Lewis. Mr. Macaulay was born in Canada, but is descended from the Macaulays of Uig, in the island of Lewis, to another branch of which Macaulay, the historian, belonged. His grandfather migrated to Aberdeenshire, and his father, Robertson Macaulay, was born in Fraserburgh, but as a young man returned to Stornoway, and a little later went to Canada, where he took a leading part in building up the great insurance company of which he was president for many years.

In memory of his father, and because of his own deep interest in the land of his ancestors, Mr. T. B. Macaulay decided to do something for the agriculture of Lewis and of Scotland generally. Probably about nine-tenths of Lewis consists of peat land, and any attempt at improving the agriculture of the island is bound up with the questions of peat cultivation. On Sir Robert Greig's advice, Mr. W. G. Coles and the writer were sent to the principal areas in Northern Europe where peat cultivation had been scientifically studied and were asked to prepare a report on modern methods, for it is a curious fact that although Scotland was the pioneer in the improvement of peat land, Scottish farmers appear to have lost interest many years ago, and all the remarkable progress in the last 30 years has been made abroad.

The Lewis Farm.—In November 1928, after studying the report,[1] Mr. Macaulay decided to establish a demonstration farm on peat land in Lewis, and this project was commenced in January 1929 under the direction of Sir Robert Greig. Mr. W. G. Coles was responsible for the drainage and for the erection of the buildings, and the writer, with the co-operation and assistance of Mr. Angus Macleod, supervised the agricultural development of the farm. The details of the enterprise have been given in two papers[2] which have already appeared in this Journal, so further description here is unnecessary. Its purpose is to study and demonstrate the best methods of reclaiming and farming peat land, to explore the possibilities of improving the great areas of common pasture, and to lend peat cultivation machinery and give advice to crofters wishing to extend their

[1] "Reclamation of Peat Land in Northern Europe." W. G. Ogg. *Scottish Journ. Agric.*, XII, 2 (1929).

[2] "Reclamation and Cultivation of Peat Land in Lewis." W. G. Ogg and Angus Macleod. *Scottish Journ. Agric.*, XIII, 2 (1930).

"Reclamation and Cultivation of Peat Land in Lewis." Part II. W. G. Ogg, Jonathan Garst and Angus Macleod. *Scottish Journ. Agric.*, XIV, 2 (1931).

holdings by reclaiming moorland. Up-to-date methods of producing and handling milk, of keeping poultry and of growing vegetables, are also being demonstrated, and as the island is almost treeless and subject to fierce gales, an attempt is being made to grow shelter belts.

Much still remains to be done, but in less than three years a very desolate tract of deep and wet peat land has been converted into a farm; an outstanding success has been the establishment of excellent pasture on which cows have been grazed for the past two summers.

Establishment of the Institute.—The problem in Lewis, where only 2½ per cent. of the land is under cultivation, directed Mr. Macaulay's attention to poorly utilised land in the rest of Scotland, and he decided to provide for the establishment of laboratories on the mainland, where research work connected with the peat land in Lewis and Scottish soils in general could be carried out. After careful consideration, Aberdeen was selected as the location for the laboratories, because the island of Lewis and extensive peat areas in the northern part of Scotland lie within the province of the North of Scotland College of Agriculture, and it was felt that close co-operation with that College was desirable.

In April 1930 the Macaulay Institute was incorporated and a committee of management appointed. To this committee of eleven members the Department of Agriculture for Scotland nominated three, the University of Aberdeen three, the North of Scotland College of Agriculture three, and the other two Scottish Agricultural Colleges one each. Professor Hendrick was appointed first chairman of the committee.

Laboratories and Experimental Grounds.—The next step was the establishment of the laboratories and experimental grounds at Craigiebuckler, on the outskirts of Aberdeen, and these, together with the farm in Lewis, constitute the Macaulay Institute for Soil Research. Mr. Macaulay has provided the capital cost and an endowment for the Lewis farm; also the purchase price and cost of equipping the headquarters at Craigiebuckler, for which he has also promised an endowment. At present the funds for the maintenance of the work at Craigiebuckler are provided by the Development Commission, through the Department of Agriculture for Scotland.

The property at Craigiebuckler consists of the mansion-house, beautifully situated in wooded grounds, and about 50 acres of land. It is only two miles from the centre of Aberdeen, and is within ten minutes' walking distance of tramways and buses. It has thus been possible to obtain at comparatively little cost ample services of water, gas and electricity from the city. The University, the North of Scotland College of Agriculture and the Rowett Institute are all within easy reach. There is a fine walled-in garden about two acres in extent, ideally situated for pot culture work, a range of greenhouses and three gardeners' cottages.

The house, which is a large substantial building in excellent condition, has from its shape lent itself admirably to adaptation for laboratories. The library and offices are situated at one end, and a thick stone wall separates this section from the rest of the building, which consists of several chemical laboratories, a geological department, machinery room, fire-proof room, preparation room, and dark room. The basement has been fitted up as a soil store, and in a further extension provision is being made for a museum. These adaptations have been carried out under the supervision of Mr. A. G. Inghan, Chief Engineer and Surveyor of the Department of Agriculture for Scotland.

A cage for pot experimental work has been erected in the garden, the high wall of which affords the protection so essential for this work. The fields are gradually being laid out in experimental plots to study the effects of lime and different systems of cultivation and manuring, but much of the field work of the Institute must necessarily be undertaken in different parts of the country where different types of soil occur.

With the approval of the Governors of the North of Scotland College of Agriculture, the Institute has also undertaken the work connected with the lysimeters at Craibstone.

The present staff consists of a director, a secretary, a soil geologist, specialists for moorland work, soil surveys and drainage analysis, a technical assistant and a part-time surveyor and advisory officer who lectures at the West of Scotland College during the winter months. In time it is hoped to add a bacteriologist, an ecologist and an engineer to the staff.

The garden work is under the charge of an experienced head gardener, who also assists with the pot and field experiments.

Very valuable co-operation in the work, especially in Lewis, has been received from the Governors of the North of Scotland College of Agriculture in allowing Mr. Angus Macleod, the county organiser for Lewis, to act as adviser to the demonstration farm, and Miss MacLeod, the county instructress, to assist with the poultry and dairy schemes. Assistance has also been received from the botanical and horticultural departments of the same College, and before the Institute was set up, the Edinburgh and East of Scotland College of Agriculture, by giving laboratory facilities and in other ways, helped to further the work in Lewis.

Previous Soil Research in Scotland.—The establishment of the Macaulay Institute has necessitated certain changes in the arrangements for soil work in Scotland, for a certain amount of soil research has been going on in all three agricultural colleges since a year or two before the war. In the West of Scotland College the developments were chiefly along the lines of soil survey and geological work, but attention has also been given recently to drainage work. As already mentioned, the soil advisory officer of this college is now working in connection with the Institute during the field season.

At the East of Scotland College soil surveys, general and detailed, have been carried out, and field-to-field acidity surveys have been made of various areas, amounting altogether to well over 100,000 acres. Attention has also been given to geological problems and to advisory work amongst farmers. A special study has been made of the methods for determining the manurial requirements of soils, and some work has been done on the improvement of hill pastures.

At the North of Scotland College a detailed investigation has been made of the properties of a northern drift soil—the soil at Craibstone. This type of granitic soil is widespread in its occurrence, and of great agricultural importance. Detailed investigations of the losses in drainage water by means of the lysimeters already mentioned have also been made. The first mineralogical investigations on Scottish soils were carried out at Aberdeen by the late Mr. George Newlands.

Co-operation with other Institutions.—Although the establishment of the new Institute has meant the curtailment of the soil work of the colleges, the change ought to be beneficial to the agricultural community, and not in any way detrimental to the functions and activities of the colleges. It is anticipated that a great many of the advisory enquiries will reach the Institute through the county organisers of the colleges, and that the latter will utilise the Institute's resources in dealing with their soil problems. This emphasises the need for close co-operation between the workers at the Institute and the county staffs and those engaged in teaching soil work at the colleges. A well-equipped soil Institute with an adequate staff will be in a much better position than isolated workers in three different centres to deal with the intricate problems of the very variable soils of Scotland.

In addition to the joint work with the colleges there will be an increasing amount of collaboration with other research Institutes. Nutrition problems such as those arising from mineral deficiencies, for example, are closely connected with deficiencies in certain soils. At the present moment the Macaulay Institute is co-operating with the Scottish Animal Diseases Research Association in questions of malnutrition of mountain sheep, and with the Scottish Plant Breeding Station regarding grasses suitable for peat land. Nutrition, disease, plant breeding and soils appear to present problems which can best be solved by the joint efforts of workers engaged in these different subjects.

Programme of Work.—It is impossible to forecast exactly the lines on which the work of a research institute will develop, as any new discovery may change the direction of all future work. In drawing up a programme for the Macaulay Institute, however, an endeavour is being made to develop the work on lines which will be of most benefit to Scottish agriculture, and whilst fundamental research is recognised as being essential to progress, stress will also be laid on the application of results to

practice. The research worker is often criticised, and sometimes not without reason, for being interested rather in accumulating information than in finding a use for the knowledge he has already obtained. As the Institute is concerned with advisory as well as research work, an attempt will be made to preserve a balance between the two branches, and to give the farmer the benefit of present-day knowledge. The methods on which soil advisory work is based are admittedly far from perfect, but a useful indication of what his soil requires will be more useful to the farmer now than exact advice fifty years hence.

1. *Improvement of the poorer classes of land.*—The total area of land in Scotland is about 19 million acres, of which just over 3 million acres is arable and 1½ million acres is permanent grass. The greater part of the remaining 14½ million acres consists of rough grazings, and most of this has a very low stock-carrying capacity. It may be grouped into the following main classes :—

(*a*) Mineral soil on steep slopes, usually shallow and often stony and rocky.

(*b*) Poor and ill-drained boulder clay.

(*c*) Heath land with a thin covering of acid peat.

(*d*) Moor land with acid peat varying in thickness from a foot to 20 feet and more.

The first of these classes may be difficult to improve on account of steepness of slopes and shallowness of the soil. The application of either lime or fertilisers, or both, would probably be profitable in certain cases.

The second class is the type from which much of the present arable land in Scotland has been derived. Much of what is still uncultivated is at an altitude of over 600 feet above sea level, and although this is unsuitable for cereal growing there appears to be no reason why some of this land up to 1,000 feet or more should not be improved for dairying or for grazing cattle or sheep. Large areas of this type of land occur in the central valley of Scotland close to great centres of population, such as Glasgow and Edinburgh. Since there is much unemployment in these areas, particularly where shale and iron works have been closed down, reclamation might be tried as a means of providing work, and at the same time of producing something useful.

Heath or moor lands are capable of improvement, and by means of motor traction and improved tillage implements such as rotary cultivators, harrows and disc ploughs, the problem can be successfully attacked, in spite of the higher labour costs of the present day. It has been shown on the Macaulay demonstration farm that good pasture can be produced on the poorest classes of peat, and attempts are now being made to reduce the costs of producing this to the lowest possible figure. Drainage is an expensive item in dealing with much of this land, but recent advances have shown that by the use of machinery the work can be cheapened considerably.

Much of the criticism of land reclamation is based on a misapprehension of what is meant. It should be realised that although a great part of the land in question is not suitable for cereal growing, there is no reason why it should not be greatly improved for grazing.

It is apt to be overlooked that less than two hundred years ago much of the present cultivated land in Scotland was in the same condition as some of the poor land which it is now proposed to improve. About 150 years ago there was a period of great activity in land improvement in this country, and some of the earliest recorded experiments in the improvement of acid peaty land were carried out in Scotland. The Highland and Agricultural Society, by offering prizes and in other ways, assisted in stimulating this work. During the past half-century, however, other countries which began much later have made remarkable progress whilst very little has been done in this country. It is felt that with the developments of recent years in motor traction and with the improvements in implements, fertilisers and grasses, the time is now ripe for renewed attempts at improving our poorer classes of land.

2. *Advisory work amongst farmers.*—An important part of the Institute's activities will be devoted to advising farmers regarding problems of draining, cultivation, liming and manuring, and advice may be obtained either by direct application to the Macaulay Institute, Craigiebuckler, Aberdeen, or through the Agricultural Colleges.

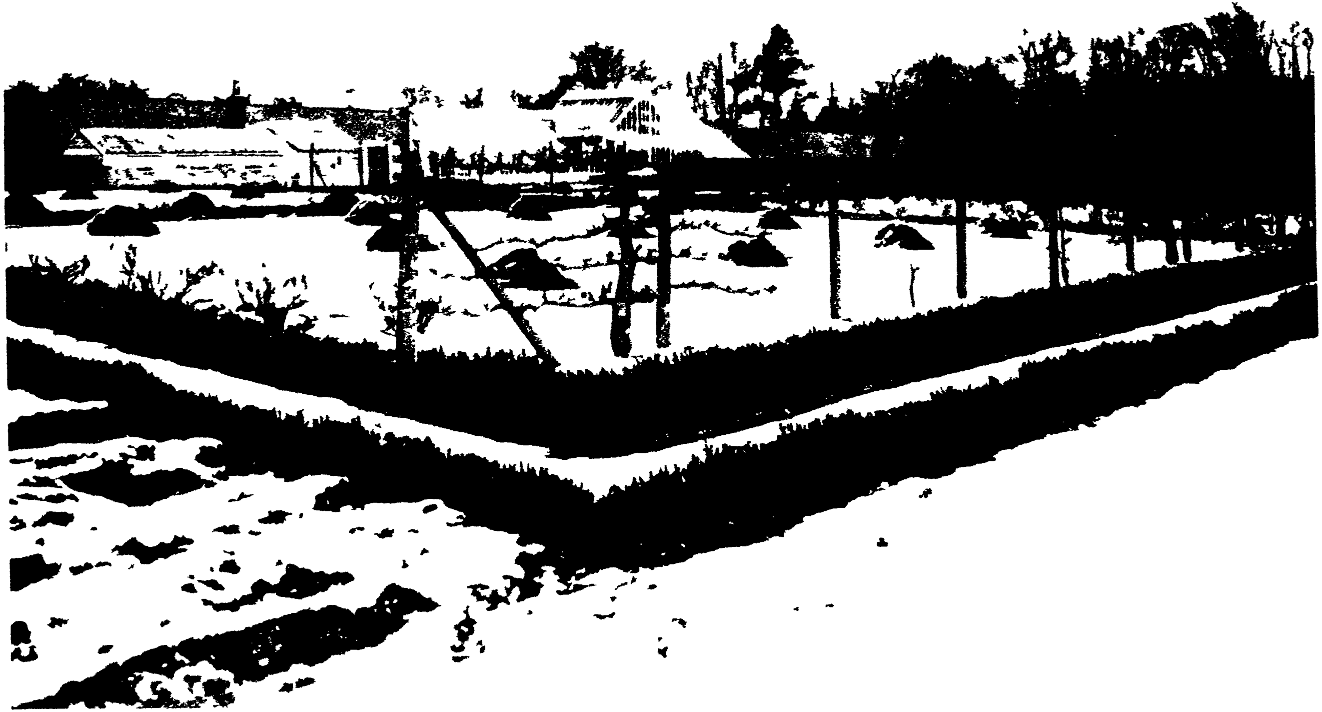
(a) *Draining and cultivation.*—In the scientific study of land draining, this country has definitely lagged behind many others. Most of our draining work is carried out in rather an empirical way, and depends for its success on the good judgment of those carrying out the work. There has been little or no attempt at improvement in method or reduction in cost, with the result that at the present time the expense of draining is almost prohibitive. In many continental countries there are fully-qualified drainage engineers, and tests have been devised which assist the engineer to decide on the type, depth, and distance apart of the drains.

Within the past few years, however, at least one firm of drainage engineers in this country has been experimenting, and by the use of machinery has succeeded in cheapening the work. Excellent results were achieved by this firm at a recent demonstration on the Lewis farm.

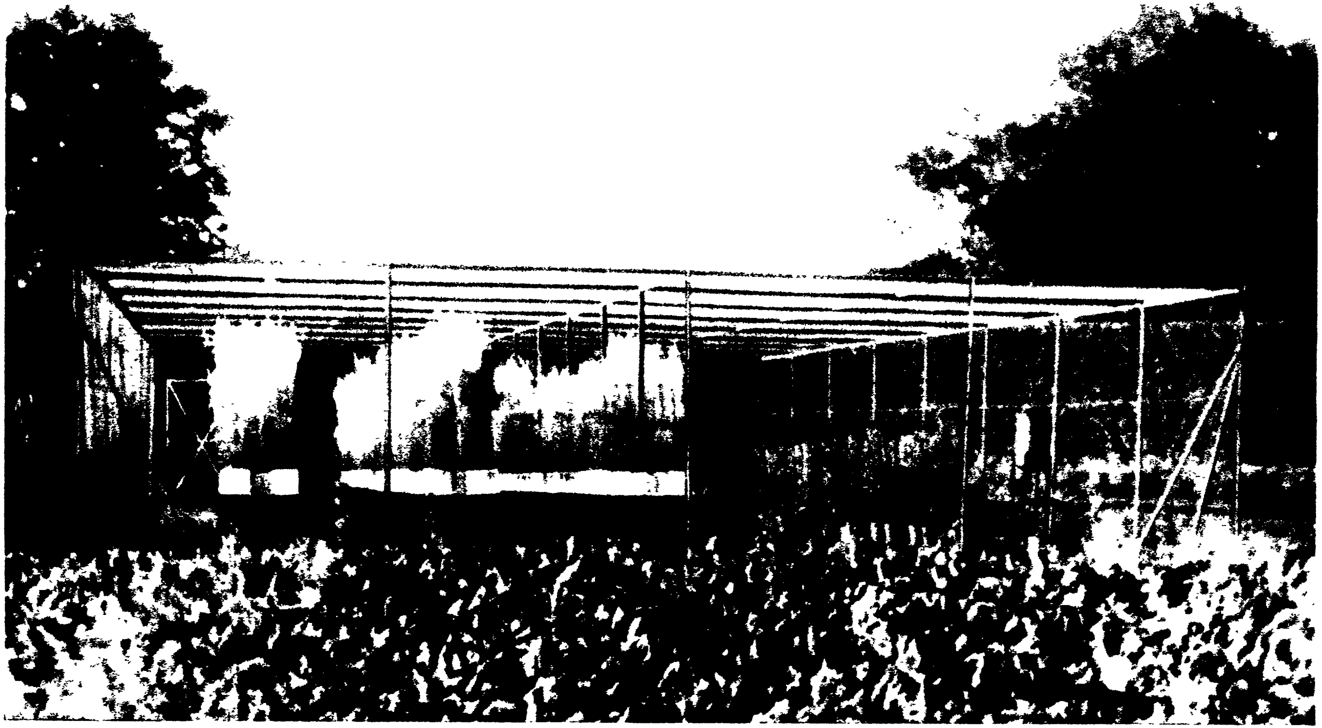
There are also possibilities of modifications and improvements in our methods of cultivation. Most farm implements were designed for horse traction, and are not necessarily the most efficient type for use with the internal combustion engine. In the improvement of the poorer types of land it is sometimes necessary to break the surface in order to destroy an undesirable existing vegetation, or to produce a seed bed or both. In peat land considerable success has been achieved at the Lewis farm

THE MANSION HOUSE

Another View of Mansion House



PART OF WALLED GARDEN SHOWING GREENHOUSES



Wire Cage for Pot Culture Experiments.

by the use of a rotary cultivator, and experiments with this will be extended to certain classes of mineral soil. Another implement which has given promising results is a new type of Swedish harrow, the blades of which revolve as the harrow is dragged along. Both on peat and on mineral soil the implement has been shown to be capable of producing a seed bed suitable for grasses.

On account of the importance of draining and cultivation in land improvement, this side of soil research will be developed at the Macaulay Institute, and, as already mentioned, an engineer will be trained and appointed whenever funds are available.

(b) *Liming.*—It may be useful to outline what the farmer can expect in the way of advice on his liming problems. The subject has been studied by soil investigators for many years, and although the advice which can be given is not as complete as might be desirable, there is now no need for the haphazard application of lime. It is possible to measure the acidity of soils, but it is not so easy to translate the results into advice on lime requirements. Soil acidity is not all of one kind, and some soils, although acid, do not respond to liming for most crops, whilst others, with the same acidity, give a marked response. In certain cases, for example, in granitic soils, this has been explained by the presence of reserves of lime which gradually become available through weathering, so that these soils may become fairly acid and still continue to grow many kinds of crops successfully. Tests have been devised for detecting and measuring these reserves of lime, and the farmer can obtain from the Institute information regarding the acidity of his various fields and suggestions as to the dressings of lime likely to prove beneficial to the various crops which he wishes to grow.

(c) *Manuring.*—The position regarding advice on manurial requirements is less satisfactory than on lime requirements. A chemical analysis of the soil might seem to be a promising line of approach, but if strong chemical reagents are used, rock and soil particles quite unavailable to the plant may be broken up, and although an analysis may show an abundance of everything necessary for plant growth, the soil may be incapable of supplying the nutrients for a satisfactory crop. Certain kinds of raw peat offer an example of this. In spite of the presence of an abundant supply of nitrogen as shown by chemical analysis, plants on such peat may suffer from nitrogen starvation simply because the nitrogen is in an unavailable form.

Attempts have been made to get over this difficulty by employing weak chemical reagents which might be expected to extract from the soil amounts of plant food corresponding to those extracted by the roots. It is difficult, however, to translate the results of these analyses into recommendations of hundredweights of fertilisers per acre, and a great deal of further research on this subject is needed.

Attempts have also been made to utilise plants as indicators

of manurial requirements.[1] In one method seedlings are grown under very carefully controlled conditions and then analysed. From the amounts of phosphate and potash which the seedlings have been able to extract, an estimate is made of the available nutrients and hence of the manurial requirements of the soil. In another method, plants are grown to maturity in pots of the soil to be tested. One set of pots contains a heavy dressing of phosphate, potash and nitrogen; in a second set phosphate is omitted; in a third potash, and in a fourth nitrogen; where there is a deficiency in any of these substances differences are seen throughout the growing season. In addition to this spectacular demonstration more accurate information is obtained when the crops from the pots are weighed, and from the results recommendations regarding manuring can be made. Although the conditions of growth are admittedly artificial, it is claimed that this test gives very useful practical information and it is used extensively in East Prussia, where the farmers have set up several testing stations solely for this purpose. In this country it was first tried at Edinburgh, and last summer it was employed at Craigiebuckler, where interesting results were obtained. It is a test which appeals greatly to farmers but is expensive to carry out, and could be done on a large scale at this Institute only if the farmers contributed, as they do in Germany, to the cost of carrying it out.

From this brief outline it will be seen that although exact information is not always available, useful indications as to the nature and amount of the fertilisers required can be obtained from the Institute.

3. *Study of drainage constituents of the soil.*—About seventeen years ago Professor Hendrick arranged for the installation of a set of lysimeters or drain gauges at Craibstone and, as already mentioned, arrangements have been made with the North of Scotland College of Agriculture for the work connected with these to be carried out by the Macaulay Institute. The purpose of the drain gauges is the study of the amount and nature of the substances which are washed through a typical granitic soil, and carried away in the drainage water. This is obviously a problem of great practical importance as well as scientific interest, for it has a very direct bearing on the processes of soil formation, on the losses of lime and manures, and on the question of unexhausted values of manures. The drain gauges consist of blocks of undisturbed soil enclosed by slate slabs, with tanks underneath to collect the drainage which passes through. They have been manured and cropped on the ordinary system for this district. Results already obtained show that on this type of soil, under the usual conditions of manuring and cropping, there is little danger of appreciable amounts of nitrogen, phosphate and potash being washed through in the

[1] "The Manurial Requirements of Soils—Two modern methods of Estimation." R. Stewart. *Scottish Journ. Agric.*, XII, 3 (1929).

drainage. There are, however, considerable losses of lime and other bases. This work has already been described elsewhere,[1] so it is unnecessary to give further details here. As time goes on the results obtained will become increasingly valuable, and it is hoped that it will be possible to extend the investigations to other types of Scottish soils.

4. *Soil Surveys.*—From the earliest days of agricultural science, workers have been seeking for some system of classifying and naming the great variety of soils found throughout the world. There may be many different kinds of soil even on a single farm, and when parishes and counties are dealt with the numbers become vast. If all these soils differed utterly from each other there would be little hope of obtaining much knowledge of more than a few of them. Fortunately this is not the case, and it is possible to arrange into groups many soils which closely resemble one another and to bring together into larger units the groups which are not widely different. In this way the knowledge obtained from the study of soils on one farm or in one district can be applied to similar soils in certain other places, and farmers can then obtain the benefit of the results of investigation and experiment. It is obvious therefore that soil surveys are of fundamental importance in any scheme of soil research, and really form the basis of advisory work. Their practical importance is apt to be overlooked, for before the results of surveys can be applied in practice a mass of fundamental data has to be collected. Soils of various districts must be examined and compared, similarities and differences studied, and the laboratory results correlated with field experiments before maps showing the different classes of soils can be prepared and the results made fully available to the agriculturist.

A great deal remains to be done before this is achieved. In order to produce detailed soil maps of the whole country in a short time a large staff of workers would be required. The preparation of a soil map is at least as complicated a business as the preparation of a geological map, and although a large organisation has been engaged for many years on a geological survey of Great Britain, it is still far from the end of its task. There was, however, an insistent demand for geological maps from those interested in developing the mineral resources of the country, and sooner or later there will be a demand by the agriculturists for soil maps. Meantime information necessary for the preparation of soil maps is being accumulated, and small areas here and there are being surveyed and mapped by a few workers. Two

[1] "The Measurement of Soil Drainage, with an account of the Craibstone Drain Gauges." James Hendrick. *Trans. Highland and Agric. Soc. of Scotland*, 33 (1921), 56-79.

"The substances removed by the Drainage from a Scottish Soil." James Hendrick and H. D. Welsh. *Proceedings and Papers 1st Internat. Congress of Soil Science, Washington*, 2 (1927), 163-171.

"A Soil Balance Sheet for a Rotation, Results obtained from the Craibstone Drain Gauges." James Hendrick. *Trans. Highland and Agric. Soc. of Scotland*, 42 (1930), 1-27.

classes of soil survey are in progress—the general division of the country into a few broad groups of soils, and the slower and more laborious detailed survey of small areas. The latter type of survey is of course more useful to the farmer, for it takes account of his individual fields, but it is slow and expensive to carry out. The general survey of the whole country into broad groups, however, may be useful in showing up important relationships, and it may be possible to correlate certain groups with tendencies to deficiencies in, say, lime or phosphate, and the farmer with land on such groups can then be on the lookout for these deficiencies on his own farm. In both classes of survey the services of a soil geologist have proved extremely useful.

In addition to the soil survey proper, another type of survey being carried out by the Institute deals with particular problems. For example, the field to field acidity survey previously mentioned is being continued in certain areas, and an attempt is being made to extend this to a survey of phosphate requirements. Surveys of this kind, although less useful ultimately than the other type, give results more immediately useful to the farmer, and for that reason are worth carrying out. At little expense any farmer can have an acidity map of his farm, which can be supplemented by the advice outlined in the section dealing with advisory work.

The soil is the fundamental raw material of agriculture, and for many years the need for a Scottish Soil Institute has been generally recognised. Thanks to Mr. Macaulay's generosity this has become an accomplished fact, and in the foregoing outline of its scope and functions an attempt has been made to show how the Institute can benefit the farmer. Without the whole-hearted co-operation of the farming community, however, the results of research cannot be applied to practice, and the Institute will lose most of its value unless farmers bring forward their problems and make use of the facilities offered. It seems probable that in future this country must produce more of its foodstuffs, and in any endeavour to achieve this end more attention will have to be given to the poorer classes of soil, which form so large a proportion of the land surface of Scotland.

THE MEAT POSITION AND OUTLOOK.[1]

Sir WILLIAM HALDANE.

THE subject of this paper, dependent as it must be on prospective values, is one of extreme difficulty to approach in the existing chaotic condition of all values in this and every other country—conditions so abnormally complex as to render past experience of little value for present outlook purposes. Indeed it is this very loss of confidence in any conjecture as to what is

[1] From an address given by Sir William Haldane at the Centenary Meeting of the British Association.

ahead that in itself is one of the worst conditions to be faced in the existing situation.

It is obvious that such a general collapse of values as has been experienced so acutely during the past two years has been due to general causes and not merely to the special circumstances of the particular commodity contemplated.

Whatever the causes, we have been left for the time being with depressed industry at a very low level in employment and with greatly reduced legitimate spending power in all classes.

It was not only the rationalised manufacturing industries that over-produced, or burdened themselves with an overload of machinery for labour saving and mass production, that have suffered. Other industries are affected similarly just by reduced demand through reduced general spending power.

The Report of the Macmillan Committee on Finance and Industry pointed out that while between 1913 and 1928 world population increased 10 per cent., the production of foodstuffs increased by 16 per cent., while that of raw materials increased by no less than 40 per cent. in the same period. Taken together the increase in production was 25 per cent. By 1930 the structure had become top heavy and collapse begun, seriously accelerated latterly by the rush for gold. Prices fell heavily. The mean of percentages of unemployed among our insured persons rose from 10·3 in 1929 to 15·9 in 1930. Similar conditions prevailed in other countries.

Obviously, in times of impoverishment food cannot be dispensed with to the same extent as many products are when general spending power goes down, but the consumption of meat is and must be so affected to a substantial degree, and with its particularly slow productive resilience to varying demand it cannot readily escape the serious effects on values of sub-normal consumption.

It is well recognised that meat is a product that has the character of both necessity and luxury, and is therefore very responsive to purchasing power. Possibly of all important food commodities it is normally most affected by rise or fall in general standard of living, at the same time responding readily as regards quantities consumed to variations in price.

This latter quality has frequently made itself evident and been commented on. It has been observed by meat traders in normal times that at a low price there is an almost indefinite demand to be satisfied in this country. Again, quality commands demand and values in a degree that strikingly demonstrates the luxury character of meat, mild though that characteristic may seem to be. The degree to which demand and price of meat depend on purchasing power has been worked out by Mr. K. A. H. Murray in a treatise on "Factors affecting the Price of Live Stock" published a few months ago, which contains the results of a remarkable research which would have proved of much greater value to-day had normal conditions still prevailed. It is true, as he urges, that demand is a most

important factor in the fixing of values, but the influence of supply must by no means be ignored, demand and supply being as necessary factors in the production of values as male and female in life. To measure the influence of the one as against the other is too intricate and too subject to other influences from time to time for exact conclusion.

With overseas countries compelled by their own adverse financial conditions to sell at almost any price, and with the advantage in having been able to sell here at an exchange profit to them of 10 to 30 per cent., as the Australians, New Zealanders and Argentines could do, it was impossible to look for any degree of prosperity for the home producer without a substantial tariff or other protection of home markets, transient though such might prove.

In regarding our home production it is not yet sufficiently realised that agriculturally ours is a live-stock country, notwithstanding that this has been impressed on us for many years by our best agricultural authorities. It has been a traditional habit to think of farming as the growing of crops, and even to measure farming prosperity merely by the merits of the cropping season without enough regard for the purposes for which these crops are grown, as though harvest were the end-all of production.

Farm *crop* production divides itself into that disposed of for direct consumption and that used on the farm for consumption by live stock, the latter being marketed indirectly through live stock. This division is one of extreme importance in agricultural economics, the two market channels being different as well as the character of the products. According to the official estimates for 1927–28, if we omit horticultural production, the ordinary farm crops grown in Great Britain and disposed of direct represented in value less than one-fourth part of the total production realised. At recent values, live stock and its products probably represent quite 85 per cent. of the total farm production value directly realised, omitting horticulture. This enormous preponderance of live stock output is of course largely due to our grain-growing in recent years being unable to compete in our main markets with importation. It must be remembered, however, that the growing of tillage crops is essential for successful live stock production in our climate.

Even were some extensive system introduced to subsidise our home-grown crop production it is impossible to suppose that live stock would cease to dominate the general economics of our farming. Hence the fundamental importance to agriculture of the meat industry, an importance which, it is satisfactory to observe, is now becoming realised by the man in the House as well as by the man in the street.

Of the value of our home production from live stock, milk and its products represent on recent reckonings about one-third part, while meat represents fully one-half, and of total meat (omitting poultry) beef and veal represent in quantity well over half, mutton and lamb well under one-fifth, and pig meat,

including lard, from one-fourth to one-third, varying from year to year.

It is obvious that, apart from dairying, the general prosperity of British farming depends on the values obtainable from these various meats, and particularly beef. As regards milk, it being naturally and necessarily sheltered from any serious overseas competition, market values have been comparatively stable, apart from varying demand dependent on general buying power throughout the country. On the other hand, meat values are influenced substantially by the competition of overseas supplies. Thus it is that milk values have maintained a much higher level as compared with pre-war values than any other important farm product, including meat—a position that has been maintained in remarkable degree, with the help of a low level of feeding costs, notwithstanding reduced purchasing power. This branch of farm production is now assisted materially by considerable marketing organisation among the producers.

It is obvious, and I think now generally recognised, that any consideration of values, present or prospective, must be based on the purchasing power of money for its real value from time to time, whether or not our currency be based on gold. Clearly currency is a true measure of commodity values only in relative reckoning at a given point of time, even though it be (inconveniently though necessarily) the continuing measure of money obligations.

Thus in considering the actual value of any commodity one must reckon it relatively to other values in money, and must likewise observe movements in value, past or prospective, in the same relationship. In other words, it is the buying power of our currency at the time that is its true value, however fluctuating that may be.

In the past two years, as we all know too well, the values in gold of practically all commodities fell heavily, gold's real value correspondingly increasing. For the twelve months alone to July last the " Statist's " index numbers showed a fall of 15 per cent. over all the classes of commodities examined, and the " Economist's " a still heavier fall. The fall in sterling values, however, was shown to be less in animal food than in most other classes of commodities. Of English beef the fall in value in the year was shown to be 8·6 per cent., though English mutton fell 15·8 per cent. The Ministry of Agriculture's price figures at mid August last showed the year's fall in prices of first quality fat cattle to have been less than 7 per cent., but of first quality fat sheep over 16 per cent., while first quality bacon pigs were shown to be down in the year about 30 per cent.

These latter figures, taken from Mr. R. J. Thompson's enlightening article in the *Journal of the Ministry of Agriculture* for September, indicate that while the sterling value of sheep and mutton had fallen about the same as commodities generally, pigs had fallen nearly double, but cattle and beef had fallen less than half the average of commodities generally during the past

year of sweeping reductions, and thus had actually risen in real value on correct reckoning.

The general lack of confidence in values, which has become a mental habit of late, discourages any endeavour to forecast what the further course of events may be, either at home or throughout the Empire. But undoubtedly the departure from the gold basis of our currency is inspiring a new and justifiable belief that in this country at least prices must now rise for all our products, agricultural as well as industrial, from the consistently low level to which they had been forced under the gold standard. Further, the altered position for home industries gives definite hope for increase in demand, which, as already pointed out, is specially important for live stock products, the trend in values depending not merely on general finance but also on purely psychological influences, even in the cost of commodities which are necessities of life.

It has been noticed that of home produced meats the consumption of beef is by far the largest. It is the cheapest meat in market price, while mutton and lamb have more luxury character and are dearer than beef and veal. Thus, beef as a necessary food most largely consumed is by far our most important meat product both to the nation and to the farmer producer in this country.

Pork and bacon are somewhat akin to beef as necessities and as having less luxury character than mutton or lamb or veal, but their home production is much smaller and varies almost from year to year for reasons dependent largely on foreign supply of bacon and ham, which would involve too much detail to discuss.

Competitive overseas supply affects all these meats to greater or less extent, and the prospects as to such must be considered, keeping in view particularly the financial pressure on every producing country in present conditions to realise its products.

As regards beef, of course the Argentine is our main source of supply from abroad, sending us over 75 per cent. of our total imports. It comes almost all as chilled beef, and it is this import that influences to the greatest degree the price level of home beef of fair quality as well as of Dominion products that compete. Our imports of chilled beef have shrunk substantially since 1926 and 1927, when during the "meat war" among the importing packing firms for control of the trade our markets were flooded with vast quantities, bringing down beef prices to a level that was ruinous to home producers and seriously affected Dominion production also.

The fall in total imports of chilled beef has been 12½ per cent. since 1927 when it reached its height, and it does not seem likely to recover much meantime. It has been falling steadily each year, though there has been some increase this year, due to continental demand having fallen away very heavily and meat formerly sent to other countries having been consigned to ours. At any rate, according to recent returns published in Buenos

Ayres and also at Washington, the total exports of beef from the Argentine and Uruguay this year have substantially shrunk.

The published reports from the Argentine for some time past have indicated that the supply of good chiller cattle for export is short, and that there is anxiety as to ability to maintain the quality of the beef sent to us. During the last two years very many of the pedigree herds have been broken up and many fewer bulls imported from this country. The Argentine Government is being urged to subsidise the supply of bulls to endeavour to maintain the quality of that country's most important export.

The complaints of the Argentine producers of the unremunerative prices paid by the Frigorifico owners, who appear now to be working in close association in buying as well as in selling, and the pressure brought on the latter recently by the Argentine Government to give the producers a remunerative fixed price, confirms the impression that Argentine production of good quality beef is not likely to increase much meantime, unless it be through further depletion of herds for a time. The disturbed conditions so continuous in Argentina are a cause for anxiety in considering our dependence on that country for our main supply of meat, and we are seldom allowed to forget the constant dangers of foot and mouth infection from South America, where the disease is widely prevalent, and has been proved to be readily transmissible through the medium of chilled meat, a danger the Argentines now admit themselves.

As regards Uruguay, from which we obtain a considerable amount of chilled beef, the census of live stock taken last year shows a substantial reduction in its cattle stock since 1924, though a large increase in sheep stocks.

It may be asked what of North America, from which to-day we are once again receiving supplies of Canadian cattle. There is nothing for surprise at this considering the enormous fall in American buying power and in consumption of food, besides the high tariff on United States imports from Canada. The army of unemployed and half employed, without organised means of maintenance, of itself would account for the underconsumption of meat in the United States and consequent heavy fall in values for the time. But the position of meat values has been seriously affected in that country by the heavy over-production of mutton and lamb in the last few years, with subsequent glut of markets, of which repeated warning was given. Notwithstanding the present condition of the United States, recently published figures show that, while imports of meat have fallen greatly, the consumption of home produced meat at present low prices has been maintained in remarkable degree compared with the average of the past three years.

Neither Australia nor New Zealand show sign of increased beef production so long as foreign countries can hold our home markets with the more attractive supplies shorter distances admit of. Meantime they rely largely on their nearer Eastern

and Continental markets. Canada knows her natural function lies in feeding the great population of North America. South Africa's prospects are still too distant, though showing definite promise. Looking all round, there is at present no indication of any material increase in our beef imports, apart from the pressure everywhere to realise assets and the fact that this country has till now attracted any surplus of commodities which other countries would not take at fair price.

The position from the point of view of our producers of mutton and lamb seems less favourable. The increase of flocks in the last few years in New Zealand, Australia and South America, and indirectly the greatly increased number of sheep in the United States, must cause anxiety lest our markets be glutted with increased imports for some time to come. So far this year there has been no material expansion in such imports beyond the substantially increased quantities we had to take in 1930, particularly of lamb from New Zealand. The live stock returns for this year show how that heavy import from New Zealand last year involved correspondingly heavy reduction in flocks in that country—a million and a quarter down in the year.

It can hardly be expected that in times of general impoverishment meat of luxury character such as lamb can escape reduction in demand, or that the higher prices for home produce can be maintained as against cheaper priced imports. Moreover, our home supplies of sheep and lambs have been rising this year and last in both England and Scotland, consequent no doubt on the better returns from sheep in recent years and their cost of production being lower than for tillage products. The danger to our producers through over-supplies of mutton and lamb has been repeatedly pointed out in the last two years and is now being realised, though this position may not last very long.

As regards all meats, the most serious prospect is the reduced demand in the present conditions of this and other countries through reduction in earnings and the enforced economies, which are likely to continue for a considerable period. The heavy fall in values these conditions have caused has so far affected beef much less than most other food, the drop being far less than in other commodities, whereas the fall in mutton prices has been fully as great as the general food average, which includes the heavily hit cereals, now however showing recovery since our departure from gold. It would seem therefore that in real value beef stands meantime much more favourably than mutton or almost any other product, and is likely to maintain its position.

Before concluding I must refer to a most serious disadvantage affecting our home production of meat—the absence in this country of any effective system for its organised marketing such as enormously helps the marketing of imported meat, particularly from South America and New Zealand, in its systematic grading, and as regards South American supplies, especially in the organised co-operation of the importers in matters of both meat supply and price.

The need for market grading as to quality is of particular importance in this country where we have two different products composing our main meat supply, beef—namely that produced as a primary product by those farmers who concentrate on meat production, and on the other hand, the production of beef as a mere by-product from cows whose primary purpose is the production of milk. It is undoubtedly the case that the absence of definite distinction in market and farm practice between these two forms of meat supply is a serious deterrent to quality production, placing the producers of the latter at a disadvantage while greatly helping the importers of carefully graded meat of fair quality, an experience in most countries where dairy products are of prime importance—New Zealand for instance.

We see the scientifically fattened cattle of north-east Scotland still commanding 60*s*. per live cwt. and the beef sold through Scottish agents quoted week after week in London much higher than Select English, and even Argentine chilled beef quoted at almost the same price as best English, and nearly always in steady demand. Surely there is something far wrong in English production or else in its marketing. The extinction of the scrub bull should doubtless help quality, but far more is required. One hears too often from well-informed quarters, particularly of late, of excessive prices for home meat being charged to the consumer as compared with the prices paid to the producer, and the consequent discouragement of consumption as meat is marketed at present.

The need for systematic co-operation among our home producers in marketing has been urged for years, and it is satisfactory that now definite machinery for this has been provided, however imperfect it may meantime be regarded by many people. But, with whatever imperfections, it would seem almost suicidal if our producers do not take advantage of the means now offered to gain for themselves a sufficient degree of control over the marketing of their products, to secure a fair share of the price consumers are willing to pay, and above all to ensure that the actual consumers' demands are properly satisfied from our own produce to the utmost degree possible and at a price that will encourage increased consumption. Whatever defects there may be in the marketing machinery designed will soon be made good if producers unite at once in organised effort, as the Marketing Act enables them to do.

It is encouraging to observe that well informed opinion hitherto somewhat opposed to the policy embodied in the statute is steadily inclining towards giving it full trial in the belief that if producers will present a united front they can insist on fair play. The outcome of such effort may have greater effect than any other factor in determining the economic prospects for home production of meat.

THE IMPROVEMENT OF HERBAGE PLANTS.[1]

Professor R. G. STAPLEDON, M.A., Aberystwyth.

THE advances that have been made in recent years in connection with the breeding of herbage plants are probably not generally appreciated. In Denmark and Sweden the work is being pursued by public institutions and by co-operative and private seed houses; in Germany to a large extent by private individuals and by farmers' associations. Russia, Norway, Finland, Czechoslovakia and Holland are all to a greater or less extent conducting researches bearing upon the improvement of herbage plants. Overseas, Dr. Pole-Evans, in South Africa, is engaged upon critical studies of grasses indigenous to that continent, while important work is being conducted at the new plant research station in New Zealand on the rye-grasses, cocksfoot, white clover and other European species which have a widespread application throughout the Dominion. Work is also in progress in Canada, perhaps more particularly with reference to red clover.

Confining ourselves to the European species of grasses and clovers in general use in this country, there are already available to the farmer a number of strains of the chief species. Thus in the case of a comprehensive trial recently conducted by a large seed house in Holland, some 86 pedigree strains all on the market were included—representing some 16 species of grasses.

In this country an appreciable number of the strains produced on the Continent are offered to farmers through the ordinary trade channels—such are, for example, the Svalöf "Victoria" and the Danish "Lündbæk" rye-grasses; the "Olsgaard" and other cocksfoots from Denmark and Sweden. Our own larger seed houses have produced and are marketing improved strains of rye-grass, cocksfoot and timothy, while some of the strains of these grasses produced at the Welsh Plant Breeding Station are now available for large scale trial; and the researches in general on the breeding of herbage plants conducted at both Edinburgh and at Aberystwyth may, with truth, be said to have begun to influence farm practice.

There are certain important and significant facts common to the work being conducted in all countries. In the first place there is a tendency to look for, and to think, rather in terms of pasture or grazing plants than in terms of hay plants: to regard persistency and leafiness as matters of supreme importance. It has been shown, moreover, that in general the most suitable breeding material is that indigenous or proper to the country for which it is desired to produce improved strains.

Although, for example, it is well known that oats like Crown and Victory bred at Svalöf in Sweden have proved of outstanding

[1] Based on a paper read to Section "M" of the British Association at the Centenary meeting in London.

value in this country, the indications are that even the best strains of rye-grass and cocksfoot bred at Svalöf are not really well suited to our conditions—not as well suited as the strains built up from our own indigenous stocks. Thus in the case of perennial rye-grass, Alun Roberts and Jones[1] have demonstrated that whereas Svalöf "Victoria" rye-grass has shown to no advantage on the basis of tiller counts over ordinary Ayrshire commercial rye-grass, strains produced from indigenous stocks by the leading firms of seedsmen have shown to very great advantage. Not only is truly indigenous material to be chiefly relied upon for breeding purposes, but also what may be described as secondarily indigenous material is of the greatest value. Of this latter fact we have several interesting examples, and none is more interesting than those from New Zealand. Cocksfoot, rye-grass and white clover were early introduced into New Zealand and they have long since become as abundant and widespread as in this country. From the plant-breeding point of view they offer absolutely parallel phenomena, namely, that the most leafy and the most persistent strains are to be found on the oldest established grass'ands. In the case of cocksfoot there are such strains on the Akaroa Peninsula where the plant was first established 60-80 years ago, and where the sward has never been subsequently broken; in the Hawke's Bay district in the case of perennial rye-grass, and everywhere on the older swards in the case of white clover. Very significant in this connection and in relation to the whole theory and practice of the production of improved strains is the detailed comparison made in New Zealand by Bruce Levy and Davies,[2] and at Aberystwyth by Jenkin,[3] of the strains of rye-grasses from the old Hawke's Bay pastures, and those from the short rotation leys of the Canterbury district. The latter are short-lived and well-nigh useless for long duration pasture formation; the former approximate more closely in the aggregate to the type of strains that are obtained from our best wild white clover pastures.

We are justified in making a further very important generalization to the effect that those strains which are most successful as "secondarily indigenous" plants in the country of their adoption—e.g. Akaroa cocksfoot and Hawke's Bay rye-grass in New Zealand—are the most likely to be of the greatest value in the countries in which they are truly indigenous. The value of Akaroa cocksfoot in this country has been abundantly proved; and in passing let us remind ourselves that when the late

[1] Roberts, R. Alun, and Jones, W. A. (1929.) Nationality and strain test of grasses (with observations on pasture analyses methods). *Welsh Journal of Agriculture*, V, p. 126.

[2] Levy, E. Bruce, and Davies, William. (1929.) Strain investigation relative to grasses and clovers. I. Perennial rye-grass. *New Zealand Journ. Agric.*, XXIX, p. 1.

Do. (1930.) Perennial rye grass strain investigation Data from trials at the Plant Research Station. *New Zealand Journ. Agric.*, XL, p. 363.

Do. (1930.) Perennial rye-grass strain investigation. Single-plant trials at the Plant Research Station. *New Zealand Journ. Agric.*, XLI, p. 147.

[3] Jenkin, T. J. (1930.) Perennial rye-grass at Aberystwyth. *Welsh Journ. Agric.*, VI, p. 140.

Professor Gilchrist first propounded the now famous Cockle Park seed mixture, the cocksfoot seed most abundantly on the British market was not Danish but New Zealand—in short was Akaroa. Hawke's Bay rye-grass, as our trials at Aberystwyth strongly suggest, would seem undoubtedly to be of value in Great Britain, as would also the best of the New Zealand white clovers. Indeed, speaking quite generally, there is evidence to suggest that these aggregate strains of New Zealand are more valuable for use in this country than are the great majority of the pedigree strains so far produced on the Continent.

These cases then are on all-fours with the behaviour of our own wild white clover and of our Cornish marl and Montgomery red clovers; and taking them all together they make the strongest possible case for organized systems of inspection of standing crops and of registration.

The use of improved strains of herbage plants in seeds mixtures demands certain precautions. It has been explained that the tendency is to breed in the direction of leafiness and persistency, and this is perhaps especially so in this country. In the immediate past practically all the seed of commerce has represented the quicker growing, earlier and more essentially hay types. The trend of competition is different with the relatively late pasture types and with the relatively early hay types, and consequently the seeds mixtures must be different. Very many of these valuable, persistent types are slow starters, and are, therefore, prone at the outset to be smothered out if sown with excess of quick-starting early types. To obtain the best results with the best types the seeds mixtures must, therefore, be simple and of a special-purpose nature.[1] The practical man must be reminded that late and persistent pasture types, from the very nature of the case, cannot be expected and will not in fact yield heavy hay crops in the earlier harvest years. All this work on the improvement of herbage plants, will, therefore, not make for maximum benefits unless or until the farmer is willing to differentiate more *clearly* between grazing leys and hay leys.

To ask the plant breeder to produce strains which will yield a heavy hay crop in the first harvest year and then produce leafy and abundant pasturage, or to produce leafy pasture strains which will withstand competition with quick-growing early strains in the first year, is to set him a problem which is not necessarily incapable of solution but is of supreme difficulty, and is indeed very far from being solved at present.

The fact remains, however, that, properly used and correctly chosen, the new pedigree strains stand in very much the same

[1] Very simple pasture mixtures are strongly advocated by the present writer. Such mixtures have now been under trial on a fairly large scale for five years in Wales. A type mixture which has done particularly well has consisted of 16–18 lb. of indigenous (*ex* wild white clover pastures) perennial rye grass: 2–3 lb. of rough-stalked meadow grass and 2–3 lb. of wild white clover. On fields of lower fertility excellent results have been obtained with a mixture made up of 16 lb. of pedigree leafy cocksfoot; 1–2 lb. of rough-stalked meadow grass; 2–3 lb. of pedigree red fescue and 2–3 lb. of wild white clover.

relation to the ordinary grass seed of commerce that wild white clover does to white Dutch. An example taken from analyses recently made by Thomas[1] at 50 centres in Wales will serve to illustrate the state of affairs. On plots sown with simple mixtures consisting of pedigree strains compared with such mixtures sown with equivalent non-pedigree strains, we have this average result in the second harvest year :—

	Sown grasses.	*Unsown grasses, chiefly fog and bent.*
	per cent.	per cent.
Pedigree strain plots	72·0	7·0
Non-pedigree strain plots ...	49·0	21·0

We now come to the all-important question of seed production, distribution, applicability and genuineness as applied to these pedigree strains, and since the seed trade is *par excellence* an international trade, this raises far-reaching and intricate questions.

The word pedigree of itself and without any qualification is deemed to act, and in very truth probably does act, as a sort of talisman and "hall-mark," but since, for reasons previously discussed, pedigree grasses and clovers of necessity have a special regional value, an international trade in pedigree strains in the aggregate, and speaking quite generally, is not desirable. It is only desirable if conducted with the greatest care and backed by highly critical tests as to applicability. For example, as already pointed out, Akaroa cocksfoot is supremely useful in this country, while only comparatively few of the pedigree cocksfoot strains from Scandinavia are preferable to the ordinary seed of commerce, yet there is a considerable trade in Scandinavian pedigree stocks in this country. This state of affairs arises partly from an undue glorification of the word "indigenous," which as such is presumed to impart a world-wide value to seeds which can be legitimately so described. Indigenous, of course, means "proper to a particular region," and by implication may in very truth almost be taken to mean "improper to most other regions"; consequently "indigenous" as such without any sort of regional qualification is a wholly misleading word—a word of about the same status as *magnum bonum* and other high-sounding varietal pet-names.

Undoubtedly in the realm of herbage plants the agriculture of the world stands the gravest risk of being flooded with new pedigree varieties, and so flooded before we have wakened up to the danger and before proper regional schemes of trial have been instituted, and before the seed trade of the world has become fully alive to the absolute necessity of conducting its operations on the basis of inspection and certification.

It is inevitable that ultimately the tendency more and more will be in the direction of the regional production of herbage

[1] Thomas, M. T. (1931.) Simple seed mixtures containing pedigree and indigenous strains compared with ordinary commercial mixtures for permanent grass. *Welsh Journ. Agric.*, VII, p. 182.

seeds; the movement in this direction is in fact fairly started. What will happen is that particular countries and particular characteristic regions will breed the strains most suitable to their own needs and take the necessary steps to grow their own seed supplies and to keep those supplies pure. This is being largely done in Germany through the formation of farmers' seed-growing associations, and every encouragement is given for farmers to grow their own grass seeds under supervision.

With reasonable and proper precautions excellent crops of high-grade grass seed can be harvested even under weather conditions which are far from favourable. The Welsh Plant Breeding Station has now been growing seed harvests of its pedigree strains on quite a large field scale in Montgomeryshire (up to 5-acre breadths per strain) for three years, and they have been three very bad harvest years, yet the yields have been of the order in lb. per acre :—

Cocksfoot	350–650
Perennial rye-grass	230–900
Timothy	400–650
Red fescue	200–480

The samples have usually been excellent with good grain weights and germination in excess of 85 per cent., often reaching 95 to 98 per cent. The greatest trouble has been with the rye-grasses which lodge badly, and meadow fescue which sheds badly. On the basis of average figures, however, the seed yields and seed quality with leafy indigenous pasture strains have been as good as those of the Danes with their stemmy hay strains.

To produce and distribute the necessary seed is then clearly but a matter of organizing the means to do so; and how absurd it is, particularly in these days when our imports vastly exceed our exports and our farm lands themselves are going to seed, to allow ourselves idly to consent year by year to the import of a vast tonnage of foreign seed—and foreign seed, be it noted, for the most part itself unsuited to our needs—while if we would only take the necessary trouble we could organize the whole business within these shores. But the matter is even more ironical than this, for, having organized the home production of seed of the type we want at home there would open up before us fine prospects of developing an export trade, both within and without the Empire, in those regions—and they are many—where our varieties of grasses, like our breeds of cattle, have become "secondarily indigenous".

There is a number of scientific points to be considered as affecting the organization of seed production and rational distribution, and brief reference must be made to the more important of these. If the seed trade in grasses and clovers is to be put on a proper pedigree footing, and if parcels are to change hands not merely on the basis of sample (the monetary value of which is assessed on appearance of the seed and on germination and purity as such), it becomes of great importance to have laboratory

tests which are competent to identify strain and variety. In this connection the researches of Linehan and Mercer,[1] who have shown that to a marked degree the classes of New Zealand perennial rye-grass as described by Bruce Levy and Davies (*loc. cit.*) can be distinguished as seedlings by their reaction to screened ultra-violet light, are not only extremely important in themselves but show directions in which we may look for varietal and strain tests. It is possible also that the osmotic characteristics of seedlings may afford another means of identification; this is a matter which has received considerable attention on the Continent and concerning which Chippindale[2] has made some preliminary investigations with strains of herbage grasses.

As to seed production there are a number of technicalities to be considered, for costs must be reduced to the minimum and yields assured. It seems evident that the larger grasses should be grown in drills and receive fairly liberal dressings of nitrogen; timothy is late to ripen, but, as well as the yield being increased, there are indications that with nitrogen the crop ripens at least a week earlier. After the seed crop has been harvested the autumnal growth of grass should be immediately cut or grazed back. Crops for seed production should not be grazed during the winter or spring; a long period of unimpeded growth is necessary for maximum seed crops. The hamper of a decaying mass of stubble or late summer growth is probably, however, as inimical to seed production as is heavy spring grazing.

The matter of isolation is probably not as fundamental as is generally supposed, and this is important if farmers will come, as they ultimately must, to grow their own crops. A well-bred pedigree strain attains to a high degree of purity and the whole crop comes into flower together, and thus the crop's own pollen by its proximity stands at an overwhelming advantage relative to stray pollen; moreover, absolute purity as to strain is entirely unnecessary in a herbage plant.

Strains which are very decidedly impure and mixed, however, deteriorate rapidly. Thus Jenkin (*loc. cit.*) has shown that it is altogether less satisfactory to "once-grow" old pasture perennial rye-grass than it is to do so with genuine wild white clover; relatively, the old pasture rye-grass contains within itself a greater excess of early and undesirable units than does the wild white clover, and these are favoured by growing-on.

In the case of new and relatively pure-breeding strains all that would be economically necessary would be for supplies of select stocks to be maintained by an appropriate organization and always to be available to the grower or farmer as and when his own stocks had deteriorated beyond the necessary standard of purity.

[1] Linehan, P. A., and Mercer, S. P. (1931.) A method of distinguishing certain strains of New Zealand perennial rye grass (*Lolium perenne* L.) by examination of seedlings under screened ultra-violet light. *Sci. Proc. Roy. Dublin Soc.*, XX (n.s.), No. 7, p. 75.

[2] Chippindale, H. G. "Suction force" measurements on the seeds of some strains of grasses. *Welsh Journ. Agric.*, VII, p. 168.

The outstanding necessity with a view to organizing seed production and distribution on the all-important pedigree basis is of course inspection and registration. Very interesting in this connection has been the system of inspection as applied locally to the Montgomery red clover and the system now adopted by the Ministry of Agriculture and the National Farmers' Union as applicable to wild white clover. It is important, however, to insist that these schemes have practical ends in view, and consequently everything must be done that is possible to make for simplification. It follows that hearty co-operation between growers, vendors, purchasers, scientists and officials can alone make for the enormous advantages that lie latent in a full appreciation of "pedigree" as applied to seeds. It is probably not too much to say that from the point of view of the ultimate value to agriculture the least difficult of all the problems connected with the improvement of herbage plants is the production of new strains by the plant breeder.

THE BIOLOGIST on the FARM.—No. XLIV.

Sir J. ARTHUR THOMSON, M.A., LL.D. (Edin.; M'Gill; Calif.; *et* Aberd.),

Emeritus Professor of Natural History in the University of Aberdeen.

Theory of Cud-Chewing.—Here is food for thought, a problem to chew at, something to ruminate or ponder over of a long winter evening. How did these sheep and cattle come to have this quaint way of eating their cake and yet having it? First of all, we may recognise the big Natural History fact that the herbivore is always threatened by the carnivore. Thus unless there be unusual swiftness, as in wild horses, or some other life-saving quality, there is an obvious advantage in reducing the time devoted to grazing in the open, and of having some retreat, such as a thicket, in which to find shelter after a meal. Thus the cattle, sheep, antelopes, and other thoroughgoing Ruminants or cud-chewers tend to eat very quickly in the open, to gorge their paunch with grass, and then to retire into safety to chew the cud at leisure. Familiar to us all in domesticated sheep is the way in which they settle down at the foot of a rock where they are safe from the hypothetical carnivore's surprise-attack from behind. In conditions of domestication a bunker is as satisfactory as a rock to the bemused sheep, but that is just what the evolutionist would expect.

In the second place, let us recall the structures involved in the rumination; and it is of interest to learn from the histologist that the so-called "stomach" of the cud-chewer is for the most part a specialisation of the lower end of the gullet or œsophagus. A study of the minute structure of the walls has shown that the first three chambers (the rumen or paunch, the reticulum or

honeycomb, and the psalterium or monyplies) really belong to the œsophagus, while the abomasum or reed represents the ancestral stomach. It is a familiar fact that the fourth chamber is the only one that secretes digestive juice. As many variations still continue to occur in the character of different parts of the food-canal of animals, there is no difficulty in thinking of the origin of constitutional or germinal variations in the area of the gullet in the ancestors of the cattle, sheep, deer, and their relatives. It is perhaps fair to say that while there is general agreement among comparative anatomists that the paunch and the honeycomb are œsophageal in nature, and comparable to crop-like outgrowths, it is held by some that the psalterium is a secondary derivative of the abomasum, one of the arguments being the presence of some glands in the psalterium of camels. In the strange deerlets or chevrotains (*Tragulidæ*) the psalterium is vestigial. The arrangements in Camelidæ are in many ways so peculiar that they seem to us to indicate a separate evolutionary origin of the ruminant apparatus in these aberrant types. But this is by the way. It should be noted that the first three chambers are *relatively* small in the suckling ruminant.

Thirdly, let us turn to what actually happens, always remembering that we are looking at the long result of time, which has taken millions of years for its elaboration. The cow grazes with businesslike zest and the paunch, with its multitudinous internal pile of short processes, becomes distended with grass. Having more or less satisfied its appetite, the cow seeks out a suitable spot, and settles down, inclined rather to one side. After a little while there is a somewhat hiccough-like spasm over the flanks and a bolus of sodden grass is seen passing up the gullet to the mouth. The complex regurgitating process has been very carefully described by Webster, but all that is very important just now is to bear in mind that it involves a succession of reflex movements, not to be thought of in any easy-going way—though they work very smoothly. It has taken ages to perfect the process.

With apparent satisfaction the cow chews the regurgitated grass, which by and by passes down the gullet for the second time. It does not enter the paunch, but passes along a groove to the third chamber or monyplies. There it is rubbed and pressed between the numerous plaits—quaintly reminiscent of a familiar musical instrument—so that what passes into the fourth chamber or stomach proper is a fluid mush, whose minute solid particles will soon be to some extent dissolved, in the ordinary course, by the various digestive ferments. Such in bare outline is the usual course of events in the process of cud-chewing. Now for our theory.

We wish to suggest that the evolution of cud-chewing began in a regularisation of vomiting. It would be more polite to say a regularisation of hiccough; but it would be less defensible. For hiccough is mainly due to a sudden contraction of the midriff or diaphragm and an arrest of an inspiration which results in a

characteristic sound. In vomiting, on the other hand, there is a strong contraction of the abdominal muscles and of the stomach muscles, as well as a contraction of the diaphragm. We hasten to note, however, that vomiting is not the right word either, for the regurgitation of the food in the cud-chewing is from the expanded end of the gullet and not from the stomach. The chief agency is to be found in the contraction of the abdominal muscles.

But the gist of our theory is that the repletion of the incipient paunch with a mass of green food, in which gas-production had set in, evoked an irritation analogous to nausea and was relieved by regurgitation. For a long time there would not be anything so perfect as a compacted bolus of suitable size, and the reflexes would be less complicated, but it is in the regularisation of an indigestion-sickness that we may reasonably look for the beginning of a very profitable alimentary habit. Variations in reflexes must have been of frequent occurrence in the course of evolution, and these novelties would be tested in the individual experience. For without assuming any transmission of the direct results of new habits—the Lamarckian view—we must never lose hold of the idea of the living creature playing its hand of hereditary cards for all it is worth.

New reflexes that are very advantageous will be of survival-value to their possessors, or will be carried for a while as correlates in the wake of variations of greater magnitude, big enough to be subject to Natural Selection. This Darwinian idea of the correlation of variations has not as yet received the recognition it deserves. If it be objected to our theory that it looks for the origin of a normal habit in a condition that is verging on the pathological, namely an abnormal state of alimentary repletion, it may be answered that we are supposing that novel reflexes, arising from germinal complications of the factors for the nervous system, were selectively approved of because they came to afford, as they increased, a more and more effective solution of a constantly recurrent condition of alimentary discomfort. Furthermore, there are many instances of the gradual regularisation of the pathological, as we see in the periodic dying away at the base of the stag's antlers, or in the gluey threads which exude from the male stickleback's kidneys and are so useful in nest-building. We beg for some unprejudiced consideration of our theory that cud-chewing is a normalising of a kind of vomiting.

The Butcher Bird's Instincts.—When Tennyson referred to the sanguinary aspect of the hedgerow, he was perhaps thinking of the " larder " of one of the shrikes or butcher-birds (Lanius), which often impales its booty on a stout thorn. A young pheasant, a mouse, a large insect and so on may be seen hanging up in the larder, and the sentimentalists (those who indulge in exaggerated feeling based on misunderstanding) have referred to the " shambles " as an instance of Nature's savagery or even cruelty. No one, indeed, will attempt to depict the shrike as a

gentle bird, but it is an absurd anthropomorphism to call it cruel. In many cases at least the victim is killed before it is impaled, and in many cases there is no impaling at all. Some recent observations by Mr. Alden H. Miller on American shrikes increase our understanding of the facts of the case. He watched young shrikes which were reared without any parental instruction and away from possibilities of imitation. He observed a generalised instinct (an inborn predisposition to a certain routine) to drag biggish booty along the perch until it caught on a projecting nail and could then be torn to pieces by the strong hooked bill. As is well known the toes are not suited for tearing. It seems then that the dexterous impaling on a thorn is an elaboration of a more generalised instinct to drag the booty along until it catches on a projection. The use in both cases is that it makes dismemberment more practicable. It seems likely that the apparent " storing " is an instance of the common continuance of a food-capturing and killing instinct beyond the limits of immediate utility. It illustrates the biological tax on a ready-made cleverness. The creature may be unable to resist killing, though it has no longer any appetite for food. Now and again, of course, the so-called larder may prove useful; but it is said that in many cases the bird does not return to what it has hung and sampled.

Adobe Secrets.—In some parts of the world, as in California, it is still practicable to build with sun-dried clay or earth, and this is adobe—a very old-fashioned kind of building material. It has recently occurred to Mr. G. W. Hendry that it might be possible to unearth some interesting history by allowing old adobe bricks to disintegrate in water. For this liberates long-imprisoned seeds, some of which are recognisable. Thus he has been able to trace back Propo wheat to buildings dating from the beginning of the eighteenth century, much earlier than has been supposed. Similarly Mr. Hendry has made the bricks reveal the fact that some alien weeds, such as certain species of dock, cranesbill and sow-thistle, were already established in California in the pre-missionary period, before 1769. The literal unearthing is yielding interesting historical results, and it is also a good instance of a method of inquiry which is so obvious that it has been for long overlooked. The very bricks may be made to cry out!

Explant Pieces of Snail.—There seems to be a notable tenacity of life in snails, as we might almost expect from their power of lying quiescent in holes throughout the hard winter. They are able to repair serious wounds and to regrow excised horns—not once only, but many many times in succession. Professor J. Brontë Gatenby of Trinity College, Dublin, has been studying recently the tenacity of life exhibited by minute fragments of snail's skin cut off and cultivated in drops of blood. They may continue living for a week, and may show active multiplication of cells and re-arrangements of these. Little fragments of muscle in these " explants," as they are technically

called, may be able to contract after several days of culture outside the body. An interesting and unusual feature in the tenacity of life shown by these microscopic cultures of snail is their relative indifference to bacteria,—for two or three days at least.

What are Genes?—An inheritance is carried, in some way that we cannot definitely picture, inside a germ-cell; and it is carried, more or less equally, by the egg-cells, produced by the female, and the sperm-cells, produced by the male. When an egg-cell is $\frac{1}{100}$ of an inch in diameter, it is not counted as very small; and a sperm-cell may be only $\frac{1}{100,000}$ the size of the egg-cell. Yet, as regards many features, it is certain that the egg-cell and the sperm-cell contribute equally to the inheritance, which is re-unified in the fertilised egg-cell and expressed in the developing offspring. But as the part of the sperm-cell or spermatozoon that enters the egg-cell or ovum is almost entirely made up of nuclear or chromatin material, there being very little cell-substance or cytoplasm, it follows that as regards many features the vehicle of the inheritance is the *nucleus* of the germ-cell. It is too soon to assert dogmatically that the whole of the inheritance is carried by the nucleus, for a little cytoplasm may go a long way, and it may be that the cytoplasm, which is often as relatively large in the ovum as it is small in the spermatozoon, may carry some of the more ancient hereditary characters. In any case the egg-cell may often count for more in the future offspring than does the fertilising sperm-cell, for the egg-cell has initial building material in its extra-nuclear cytoplasm. It will be understood that when an egg is really large, like the egg of a salmon or of a hen, this means that there is a considerable legacy of nutritive material or yolk. The amount of genuine living matter—the formative material, whether nuclear only or nuclear and cytoplasmic together—is never large. It must also be understood that the nourishment of the developing offspring within the mother before birth is not to be counted in as part of the inheritance, for though it is characteristic of *mammals*, it is not illustrated in the majority of animals.

It may be stated, then, as a biological certainty, that many at least of the hereditary characters of our sheep and cattle, of our turnips and cereals are carried in the germ-cells by the chromatin material of the nucleus. This chromatin, so-called because it stains readily and can thus be more readily studied under the microscope, tends to be grouped in distinct bodies or chromosomes, definite in shape in different types and definite also in number. The smallest number of chromosomes in a cell is two, as is seen in the threadworm (*Ascaris*) of the horse; one of the large numbers is 48, which occurs in man. No great importance can be attached to the particular number of chromosomes, thus man's number occurs also in one of the snails and in one of the plantains; the point is that the number, whatever it may be, occurs constantly throughout the cells of the

body, except that the ripe ova and the ripe spermatozoa have half the normal number. When the egg-cell is fertilised by the sperm-cell the normal number will be restored.

Another interesting point about the number of chromosomes has been demonstrated in a number of cases, both among plants and among animals, that related species sometimes show an arithmetical series of chromosome numbers. Thus some species of rose have 7 chromosomes, others 14, others 28, and so on. It is known that a sudden novelty—whether we call it a freak or a mutation or a discontinuous variation, matters little—may be associated with a doubling of the number of the chromosomes in the germ-cells.

Another point of interest in regard to the number of chromosomes in a particular kind of living creature—whether horse or threadworm, turnip or bean-plant—is that it may sometimes throw light on the failure of crossing or hybridising. When the chromosome-numbers of two different species are quite different, it is not likely that there will be a successful cross, and it is still more unlikely that the cross, if it comes off, will be fertile. But here we must draw back from deep waters.

Yet another point, which touches us all. It often happens that the cells in the male's body have one chromosome fewer than those in the female's body. Thus man's number is 47, but woman's number is 48; and thus we men start handicapped! Now in those mammalian types that have been carefully studied there seem to be two kinds of ripe spermatozoa, which occur in equal numbers, one half with, and one half without, a special "sex-chromosome." In the female, however, the ripe egg-cells are all alike, each with a "sex chromosome" as well as half the usual number of ordinary chromosomes. When an egg-cell is fertilised by a spermatozoon carrying a special "sex-chromosome" along with half the usual number of ordinary chromosomes, the result is likely to be a girl (with 48 chromosomes in all). When an egg-cell is fertilised by a spermatozoon without a special "sex-chromosome," the result is likely to be a boy (with 47 chromosomes in all). As this applies to mammals in general it is plain that what appears at first sight very technical is really of profound practical importance. The theory is important, as yet, in enabling us to understand more clearly what occurs, but in days to come it will probably help man to control as well. But let us return to the microscopic vehicles of the hereditary characters!

When a cell has been fixed and stained to facilitate microscopic examination, the chromosomes sometimes appear almost too distinctly, like very solid rodlets or V's or spheres or threads; but in the living cell they are very fluid and somewhat vague in outline. One of our poets has spoken of a sausage as "a little bag of mystery," and that is what a chromosome is —a very intricate colloidal sausage surrounded by a delicate film. Under high magnification it is sometimes seen to be divided into a number of regions, presenting in the living state a somewhat

irregular contour. In these parts of the chromosome and probably in longitudinal order, like a row of beads, are the "genes"—which are in some ways the most important things in the world. For a gene is a differentiation—probably a little particle or blob—which is the hereditary initiative or representative of a hereditary unit character. A "gene" or "factor" is the germinal counterpart of a normally non-blending and non-splitting characteristic or feature, but it must be understood that several genes may go to the development of one feature, such as the colour of the hair; and that one gene may influence the development of several distinct features in the organism.

A question often asked is whether one can see a "gene," and it is possible that a visible minute nodosity on a chromosome is occasionally a single gene In most cases the little swellings are more probably linkages of genes. In indirect ways, however, which cannot be very briefly described, it is more or less certain that the genes lie in linear order on the thread of the chromosome; that groups of them may pass from one chromosome into another which crosses over it; that they can move as units; and that they are capable of some change in molecular structure Dr C B Bridges has pictured a gene as the central core of a minute body containing sap enclosed in a film He suggests that though we may not be able to see the genes themselves, we can see the tiny houses in which they live The most certain fact in regard to genes is that they are the most important little bodies in the world, and therefore very much within the purview of the Biologist on the Farm. We run the farm on genes

Is there Telepathy among Birds?—One of the rules of scientific method is to refrain from a difficult hypothesis when a simpler one will serve to sum up the facts This rule is called the law of parsimony, and we must seek to obey it as far as in us lies A veteran investigator sometimes advises an impetuous youngster to "use William of Occam's razor," meaning that he should shave off all unnecessary assumptions. William of Occam (1300-1349) was a Schoolman of Surrey, famous in his day, but best known now for his dictum *Essentia non sunt multiplicanda præter necessitatem*, Essences or entities are not to be multiplied beyond what is necessary. One does not need to postulate a principle of "horology" for clocks—they go quite well without one; but all cases are not so simple as that. Thus some people use the word Heredity, or the word Evolution, as if it stood for an entity; and that is bad science. Part of the work of science, indeed, is to change entities into actualities or events that can be measured Thus the entity "Vital Force" has been more or less changed into the properties of protoplasm.

In plain English, however, the law of scientific method to which we are referring is just that we should always try the simplest theory first, and keep to it if it fits the facts approximately well Yet we should at the same time bear in mind the caution that when we are dealing with very difficult problems,

not investigated with much exactness, like those of human conduct, or those of cattle-breeding, we must not be too sure that the simplest description or explanation is the right one, although it seems to fit the case. A man's motives may be ever so much subtler and nobler than those you give him credit for, and an animal's intelligence, character and temperament may count for more than you are at first inclined to allow.

What we have been saying may seem a long way from the farm and from birds, but its relevancy is not far to seek. Mr. Edmund Selous, a past master in the observation of birds and a very shrewd naturalist, has been led to the conclusion that they sometimes behave in a way that suggests thought-transference, and the question is whether some simpler hypothesis will not suffice. Before we state his case we must notice, though without dogmatism, that while there are some carefully observed facts which suggest thought-transference from one human mind to another, the actuality of this true telepathy has not been demonstrated. Some careful investigators are firmly convinced that certain facts are inexplicable on any explanation except that of actual thought-transference, but even that conviction is not perfectly logical since there may be some other explanation unknown to us. All that we are logically entitled to say is that we do not know of any other explanation. And this caution must be kept in mind when we consider the theory which Mr. Selous suggests in regard to simultaneous action in a large flock of birds on occasions when a common external stimulus cannot be detected. The absence of another explanation does not prove that thought-transference is the right one.

As we walk about and rest awhile we sometimes see a flock of birds sitting quietly in the field of near observation. They may be rooks, gulls, curlews, dunlins, geese and what not. All of a sudden they take wing, we know not why; and it is this simultaneity of taking flight that Mr. Selous has studied over and over again. It must be remembered that we have to serve a very long apprenticeship before we come near the precision of observation that a past master like Selous has come to have. What he feels sure about is that the taking wing is quite simultaneous and it cannot be explained by supposing that the members of the flock become suddenly aware of some stimulus that affects them all at the same moment. We know how the appearance of a dog may set sheep a-moving, or how certain flies suddenly provoke a stampede of cattle, but Selous's theory is that the impulse travels telepathically, that is apart from *ordinary* sense-stimulus, from bird to bird. They rise simultaneously and unanimously,—a profitable thing to do.

Now we do not think that a hypothesis of this sort is to be brushed aside because it is unusual. What we should ask ourselves is whether simpler hypotheses will not serve, and with this question in our mind we should make observations when we have a chance. It may be noted that simultaneity is not very readily proved without photographic apparatus. The simul-

taneity with which the competitors start at a village race provokes a smile from the professional. It is not easy for you or me to be quite sure that all these peewits rose simultaneously, or to be sure that there was not some stimulus that they all saw or heard at the same time. We must remember that a nerve-impulse often travels in ourselves at the rate of seventy miles an hour. Another idea to be considered is the sameness of vital processes in similar animals in the same conditions. We do not allow enough for uniformity of vital action, just because we are so often impressed with individuality. But we are merely suggesting an interesting problem, for which Mr. Selous has offered a courageous solution. The question is whether his theory is *necessary*.

THE ART OF STOCK BREEDING.[1]

Professor J. A. S. WATSON, M.C., B.Sc., University of Oxford.

WHEREAS crop improvement has now become very much of an applied science, and is carried on mainly by scientific specialists, live stock improvement has been left almost entirely in the hands of practical farmers and has remained essentially an art. Our present-day methods are almost entirely empirical; they have been arrived at, stage by stage, by a process of trial and error that has been going on for many centuries.

We find, if we go back to the beginning of things, a good deal of evidence that the first result of domestication was a marked deterioration of the species concerned. Domestication seems, in its early stages, to have been a bad bargain for the beast. The earliest remains of domesticated animals date from the so-called Neolithic period, and in Europe go back to a time about 2000 B.C. We cannot of course know whether stock breeders at that remote period made any attempt to improve or to maintain the quality of their stock; but it seems clear that, if they did so, their efforts were very unsuccessful. All the early types—the so-called *Bos longifrons*, the turbary sheep and the Neolithic pig—were stunted, puny, degenerate things compared with their respective wild relatives. But indeed we do not need to go back to prehistoric times for such evidence; we get essentially the same picture in parts of Asia and Africa to-day, a picture of some of the most miserable of domesticated stock living alongside the largest and finest wild animals of the world.[2]

I am disposed to believe that the oldest method of live stock improvement consisted simply in going back to the original wild source of fresh blood. It is only by supposing some such

[1] Paper read before the British Association, Section M, September 1931.

[2] In the subsequent discussion Mr. Alex. Holm, Director of Agriculture, Kenya Colony, pointed out that native African peoples often exercised deliberate selection, though their standards and ideal types were peculiar. Certain peoples regarded small size as a most desirable character in cattle; others deliberately strove to increase the size of the horns, &c.

process that one can explain the appearance, in Bronze-age Europe, of domesticated stock resembling quite closely the co-existing wild types, and differing markedly from the domesticated forms of the earlier (Neolithic) period. It is possible that prehistoric man may have caught and tamed the calves of the wild Urus, or the young of the wild boar. But it is more likely that he deliberately allowed his female stock to mate with wild males. This is still occasionally done—for instance with buffalo cows in those parts of India where the wild buffalo exists. Apparently it was also done in classical times. Our common word "hybrid" comes from the Latin "hybrida," which originally meant a cross between a domesticated sow and a wild boar.[1]

Turning to our own country and to the times of the earliest written evidence we find that the quality of the stock was still very poor. For example sheep were kept principally for their wool, yet Thorold Rogers[2] has calculated the average weight of a large number of mediæval English clips at just under one and a half pounds per fleece. Moreover, if we judge by the specimens of early English cloths that have been preserved, the quality was no more satisfactory than the yield; the wool is coarse and mixed with hairs. Fitzherbert, writing in the early sixteenth century, recommended that ewes should not bear lambs until they were three years old, which must indicate either slow maturity or unsatisfactory food conditions, or probably both. In 1500, according to Lord Ernle,[3] the average weight of a mature sheep's carcase was not more than 28 lb.

Thorold Rogers[4] points out that there must have been widespread and general efforts to improve the breeds of sheep in mediæval times, as is shown by the relatively high prices paid for rams; these were often substantially higher than the prices of the best wethers. There is, however, he says, no corresponding evidence in the case of cattle, a fact than can probably be explained if we remember that wool was an important article of commerce and its quality would be immediately reflected in the price obtained, whereas there was practically no trade either in beef or dairy products. It is true that in all the early agricultural books—Fitzherbert, Tusser, Markham, Mascall, and so forth—the "points" of a good bull, or cow, or ram form a regular part of the subject matter; but the "points" are chiefly those which indicate vigour and constitution rather than those which suggest usefulness for any particular purpose.

That progress in those days was slow at the best, and at the worst was backwards, is fairly clear, but all the circumstances were such as to make progress very difficult. Take sheep again

[1] Pliny, *Natural History*, VIII, 53:—"In no kind of stock is admixture with the wild so easy as in the case of pigs; the ancients called such as were bred in this way 'hybrids' or 'half wilds.' . . . Moreover it is not only among pigs that this is found, but among all animals where there are wild and tame of the same species."

[2] "Six Centuries of Work and Wages," p. 80.

[3] *English Farming Past and Present*, p. 98.

[4] Op. cit., p. 79.

for example. Food conditions were poor and starvation fairly common; the rate of increase was consequently low—perhaps 70 lambs per 100 ewes; the age at which breeding began was high—commonly three years; and the death-rate due to liver fluke, scab and other diseases was very high—probably 10 or 15 per cent. per annum. It needs only a simple calculation to show that it must have been necessary to keep practically every ewe lamb, good or bad, for the flock—as on our poorest and least healthy mountain grazings to-day. We know indeed that this was so, for always after a specially severe epidemic several years were required to build up the flocks to normal numbers.

Up till the seventeenth century it would seem that the sole guiding principle of the breeder was to pick out the best individual males as sires and to cull out the poorest of his female stock whenever a run of favourable seasons made this possible. The next stage, the appreciation of the value of pedigree, was reached very slowly. Probably the most important factor in arousing interest in animal genealogy was the introduction of racehorses in the time of Charles II, and the foundation of the thoroughbred breed in the reign of Queen Anne. At this time people who had leisure to read and to study pedigrees were not interested in cattle or cart horses; that did not come till later; but the racehorse was recognised as a proper subject for serious study by the educated and leisured classes, and thus the habit was formed of thinking in terms of pedigrees. Before the end of the eighteenth century the custom had spread to breeders of all classes of stock except pigs and poultry.

We come then to Bakewell and his contemporaries. Bakewell, as has often been said, conceived a new type of animal—a kind of meat-producing machine, through which it would be possible to exploit the new resources in the way of fodder crops and to supply the growing demand of the towns for meat. But here he established no new principle of general application. The new principle that he did establish was that of testing, by means of trial matings, the respective merits of his male animals—of selecting sires according to the quality of their progeny. This is what scientists now call genotypic selection. It has proved the most fertile of all the guiding ideas that have emerged from centuries of experience. Thus, about the year 1770, the three main rules to which we work to-day were finally established: breed the best to the best; study ancestral merit as well as individual merit; and make the final selection of the sire after a test of breeding performance. Bakewell also began a controversy on the subject of inbreeding and outbreeding which has lasted to our day, and to which we must in a moment return.

It is not, of course, suggested that progress ended with Bakewell, or that the outlook of the modern breeder is the same as that of his great-grandfather. For one thing a mass of crude and unscientific beliefs that once formed a part of the working theory of the breeder has been gradually swept away. One can indeed still find people who believe that Jacob, when he set up

the half-peeled wands in front of his breeding ewes in order to get ring-straked lambs, was acting upon a sound principle. One can still find people who believe in Telegony. One can still find people who hold that modifications, due to feeding or other causes, may be transmitted to the progeny. Almost every time one speaks to a public meeting about breeding one is told of some infallible—or nearly infallible—system for the control of sex; unfortunately almost every one of these theories is cancelled out by another which rests upon the same alleged principle applied in the opposite sense.

It is of course not surprising that these beliefs exist. Chance plays a very large part in determining the characters of the particular animal, and the play of chance is, to some minds, the least acceptable of all explanations. Thus we find roulette players spending laborious days inventing "systems" to account for the succession of reds and blacks, and breeders searching for a reasonable explanation of the fact that one particular calf is male instead of female, or white instead of roan. Modern genetical science has of course made possible the calculation of chances where these were formerly incalculable, but there are some breeders, as there are some roulette players, to whom the science of chance makes no appeal because it does not apply to the individual case.

Inbreeding and outbreeding have been carried on side by side for a century and a half. Intermediate systems have been tried, such as "line breeding" and the alternation of close inbreeding with out-crossing. A great deal of empirical information has been collected and a great deal of effort has been made to interpret and reconcile the results. It has been found for instance that inbreeding tends to fix type while outbreeding tends to increase variability. It has been noted that inbreeding often results in a weakening of the strain, lessening size, slowing down growth rate, reducing fecundity and lowering the power of resisting disease. But these results sometimes appear quickly and obviously, sometimes slowly and to a scarcely appreciable extent. It has been noted that sheep have been inbred with much benefit and little harm, while the same process applied to pigs has generally ended in quick disaster. On the whole it has been true that the really great breeders, the men who have created new types or otherwise left a permanent mark upon their breeds, have been inbreeders; but it has also been noted that many men who have apparently gone upon the same lines have achieved little or nothing. On the whole it might be argued that the broad practical conclusion is that the inbreeding is the system for the pedigree man, if he can afford to spend freely and wait long, while outbreeding is the scheme for the workaday commercial stockman.

Modern statistical methods have been applied to the problem. The procedure is as follows. First there is devised a measure of the degree of relationship obtaining between the ancestors of a particular animal—a numerical expression called the

"coefficient of inbreeding" or by some such name. A particular breed is then chosen, and the average degree of inbreeding is calculated from a representative sample of the recorded pedigrees. The same procedure is adopted for a selected group within the breed—perhaps 1,000-gallon cows, perhaps racecourse winners or showyard winners—and the average figures are compared. Evidence is thus obtained as to whether inbreeding is upon the whole beneficial or harmful, or as to the degree of inbreeding which, upon the whole, produces optimum results. A good many breeds have now been subjected to such analysis, but the results provide little guidance to the breeder. In general it may be said that the selected groups of good animals are not significantly more or less inbred than the average of the breed. It is clear that carefully planned scientific experiments are necessary if the question is to be taken further.

It is a question for interesting speculation as to how many generations must elapse before we exhaust the possibilities of our method. It requires only a glance at a few old albums of live stock pictures to assure us that all our breeds of stock are still changing and, according to our lights, changing for the better. But in many cases the purpose has changed, or the demand of the consumer has changed, or the fashion has changed. It is perhaps a little doubtful what Charles Colling or Bates would have to say about the modern Shorthorn, or David Riddell about the modern Clydesdale, or Culley about our Border Leicester sheep. In all cases, there is no doubt, the ideal has shifted to some extent. In order to study the results of the breeder's labours one must choose a case where the same aim has been constantly before the breeder's eyes, and where the achievement can be measured in figures. One naturally thinks of milk production in the dairy cow, or of egg production in poultry; but here, unfortunately for our enquiry, the advance in nutritional science and in management has been such as to invalidate our comparisons. It is quite certain that no 2,000 gallon records were made till recently; it is far from certain that potential 2,000 galloners did not exist a century ago. There has been, for probably 200 years, a constant desire for greater size and weight in our draft horses, and it would seem that the average height has increased in that time by about 6 inches and is probably still slowly rising. Actual figures do not exist. In breeding thoroughbreds we have had the almost single aim of increased speed for about the same period of two centuries, and the Eastern breeds from which our racehorses are derived had been selected along somewhat similar lines for some centuries more. The time taken to cover the Derby course is one obvious source of information, only unfortunately the weight carried has been repeatedly altered. Broadly, however, it would seem that the thoroughbred is still getting faster, if only by a very little. A new record of 2·43 was established in 1861; this was equalled in 1864 under 3 lb. more weight, and again equalled in 1888 under a further addition of 4 lb. In 1910 the course was run in

2·35¼ and in 1920 in 2·34¼. Increased skill in training may of course account for some part of the improvement.

The best available figures seem to be for the time, over the mile on an oval track, of the American trotter. The records as they stood at the end of each decade since 1810 are given below :—

1820	2·48½	1880	2·10¾
1830	2·37	1890	2·08¾
1840	2·32	1900	2·03¼
1850	2·28	1910	1·58½
1860	2·19¾	1920	1·58
1870	2·17¼	1930	1·56½

Again, better training, better racing equipment, better tracks, and so forth, may account in part for the increase in speed. Moreover it is obvious that improvement has become progressively slower and that, short of something of the nature of a " sport," further improvement is likely to be a matter of a very few seconds in the record. But there is nothing to show that an absolute dead end has yet been reached. The same conclusions would probably apply to other classes of stock bred for other purposes.

CONTROL OF LEAF STRIPE or YELLOW LEAF OF OATS.

D. G. O'BRIEN, Ph.D., and R. W. G. DENNIS, B.Sc.

THE leaf stripe disease of oats was first reported as commonly occurring in Scotland by O'Brien and Prentice in *The Scottish Journal of Agriculture,* Vol. XIII, No. 3, pp. 272-84. In this article some indication was given as to the benefits arising from seed disinfection.

During the summer of 1931 a considerable acreage of oats (over 50,000 acres) was sown with disinfected seed by farmers in all parts of Scotland. The results obtained were in almost all cases very striking and may be outlined as follows. The braird on the treated fields was thicker on the ground, the plants more vigorous and more forward than on untreated sections. Where counts were made of the number of seedlings established in a definite area, in many cases four times as many plants were found in the treated sections as in the untreated. It was unfortunate, however, that very few farmers who disinfected their seed, sufficiently reduced the rate of seeding from that normally practised. This oversight tended to diminish the value of disinfection as the season advanced. The great increase in number of successfully established plants and the consequent thickening of the crop on the ground resulted in a tendency to lodging, which interfered to a very great extent with the securing

of comparable results between yields of treated and untreated areas. Where a reduction in rate of seeding was practised, the benefits of disinfection were apparent throughout the growing season, many farmers reporting that the crop upon the treated section was ready for harvesting seven to ten days before that on the untreated. The actual increased yields of grain of treated

FIG. 1.

over untreated sections were necessarily varied. The highest increase in yield recorded was that of 12¼ cwt. per acre—admittedly an exceptional result—the crop in question being grown from Ascot oats which had showed very high infection of the untreated seed. It is estimated that the average increase in yield of grain due to disinfection represents a money value of about £1 per acre.

As there is likely to be a very great increase next season in the area of oats grown in this country from disinfected seed, it may be of interest to deal in the present article with the methods recommended in mixing grain and disinfectant. The disinfectant (Ceresan) which we recommend is in the nature of a very fine powder, and a requisite of efficient treatment is that a film of the powder completely coats each individual grain. This serves to keep under control the fungus present on the exterior of seed derived from a crop infected the previous season, and to prevent it damaging the sprout of the germinating seed.

The actual mixing process can be carried out in various ways but preferably always in a closed container. The latter may be in the nature of a modified churn as shown in Fig. 1. Satisfactory results may also be obtained by the use of a barrel

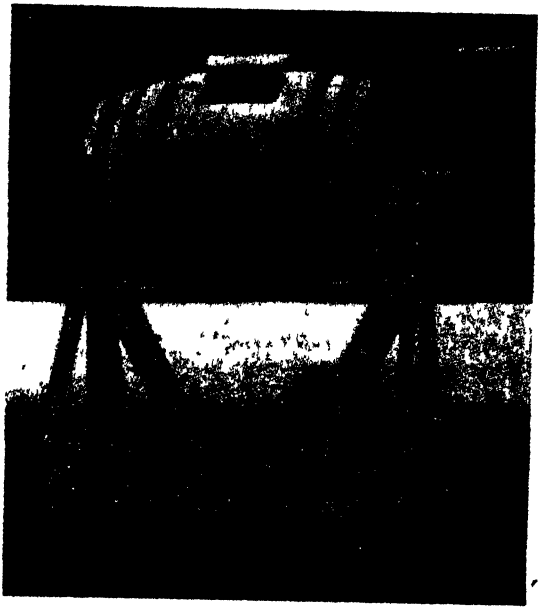


FIG. 2.

rotating around a horizontal longitudinal axis, and having a hole of suitable size cut in the side for use in filling and emptying (Fig 2). An improvement is perhaps to have two openings, one for filling, the other for emptying (Fig. 3). These holes must be readily opened or closed at will. Whether barrel or churn be utilised, it is essential that a series of vanes be inserted on the inside for agitating and thoroughly mixing grain and disinfectant during the rotation of the receptacle.

More complicated disinfecting machines are now on the market, such as that illustrated in Fig. 4. This consists mainly of a cylindrical horizontal drum in which the grain is rotated after receiving the appropriate quantity of Ceresan. The latter is supplied from a small container fixed to the side of the hopper from which the grain is fed into the drum on rotation. The most

improved machines of this type contain a mechanism in the form of a piston working in the base of the Ceresan container. At each rotation of the drum the piston forces into it the appropriate amount of powder.[1] In addition the mixer illustrated is so designed that the amount of powder added is maintained in the same proportion to the amount of grain entering the drum, irrespective of the rate of rotation. The capacity of the machine

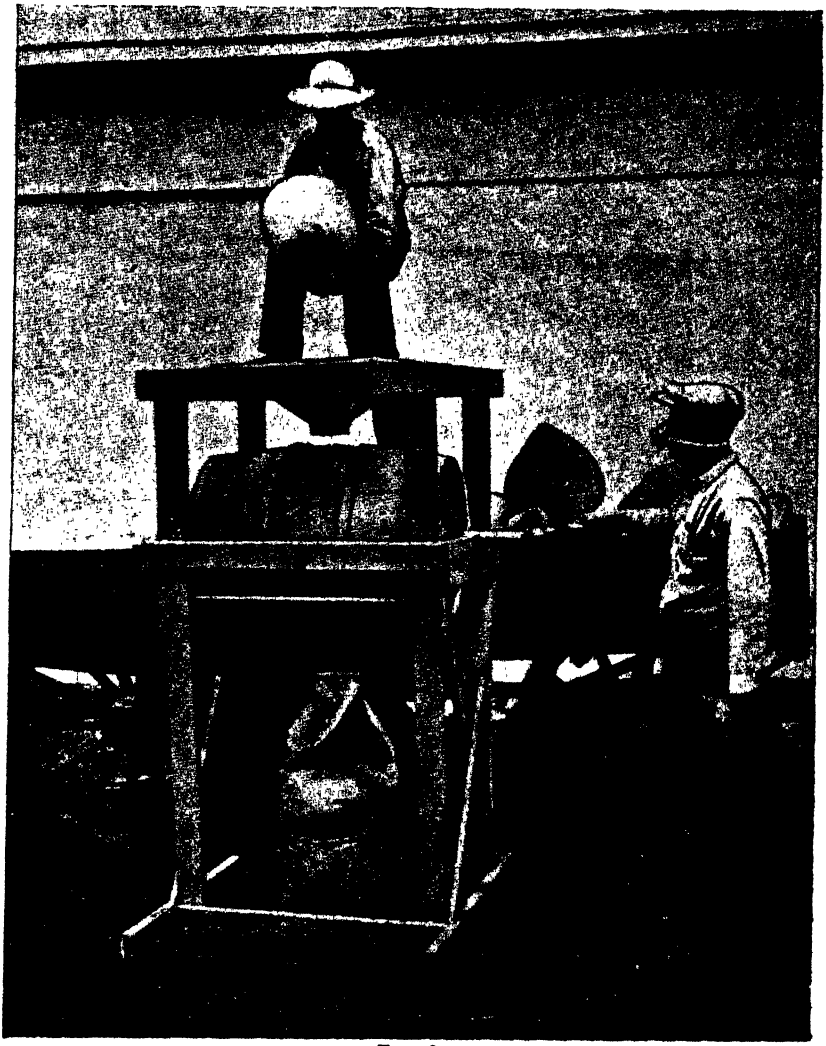


FIG. 3.

illustrated is 15 cwt. of grain per hour. The makers are Messrs. Watson, Agricultural Engineers, Ayr, and the cost is £6. It can be operated either by hand, or a pulley can be placed in the axle and driven from shafting already installed on the farm.

[1] A serious fault existed in the older machines where no such forced feed for the powder was installed. It was found in practice that there was a distinct tendency for the powder to cohere and clog the opening into the mixing drum.

During the process of disinfection of grain by dry dusts, a certain amount of the fine powder used always escapes into the surrounding air. If the building in which the process is being carried on is thoroughly ventilated, this may not cause serious annoyance, but in a closed room, and especially where a large amount of grain is being handled, serious inconvenience may result. The inhalation of the powder into the lungs causes local

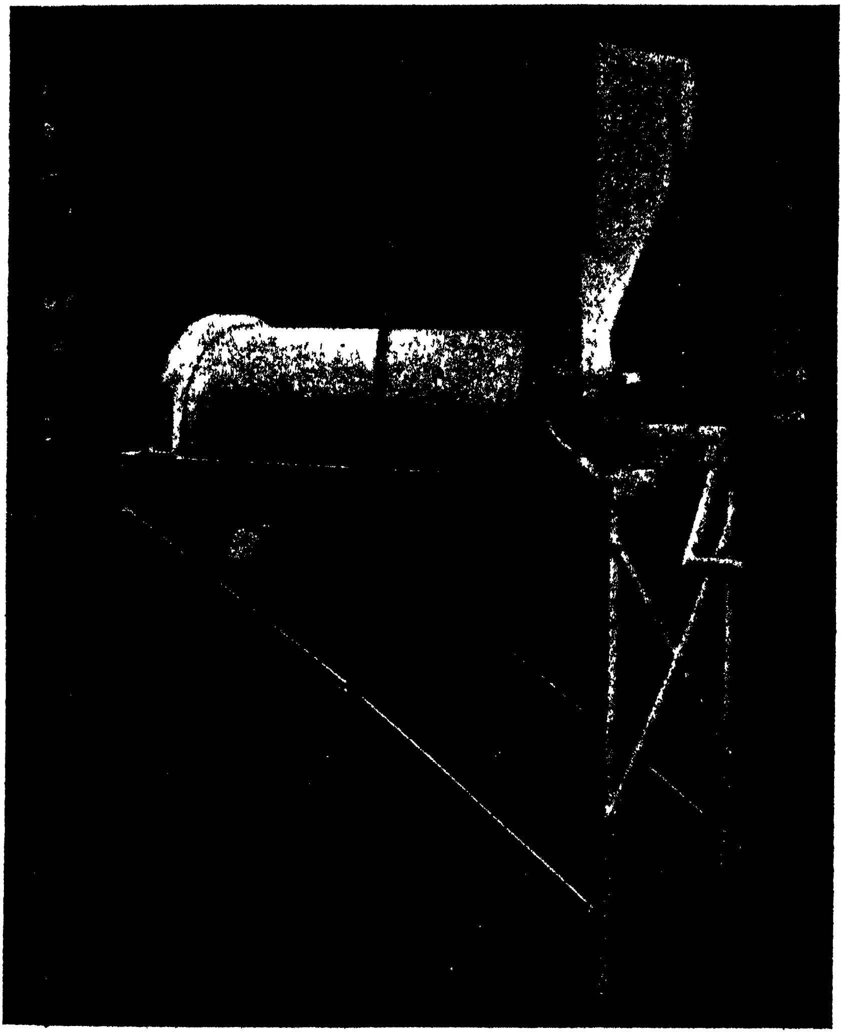


FIG. 4.

irritation, the effect of which may in certain circumstances be felt by the operator for some days after. We would therefore recommend that where a large amount of grain is being handled at one time an inexpensive mask of the type shown in Fig. 5 be worn. In the event of a mask not being available a wet handkerchief or cloth may be tied over the mouth and nose, and will be found to give a considerable degree of protection to the wearer.

A special precaution recommended to those troubled by weak eyes is to wear motor goggles during the actual mixing process.

Any of the above methods of seed disinfection can be relied upon to produce satisfactory results. The least satisfactory method of mixing powder and grain is to spread the grain out on the floor of a granary or other suitable building and scatter the required amount of disinfectant over the top. The heap is then turned over three or four times with a spade. We cannot recommend this practice as a considerable amount of the powder is lost and the surface of the individual grain is found not to be satisfactorily coated. Moreover it is obvious that when the mixing

FIG 5 (*a*).

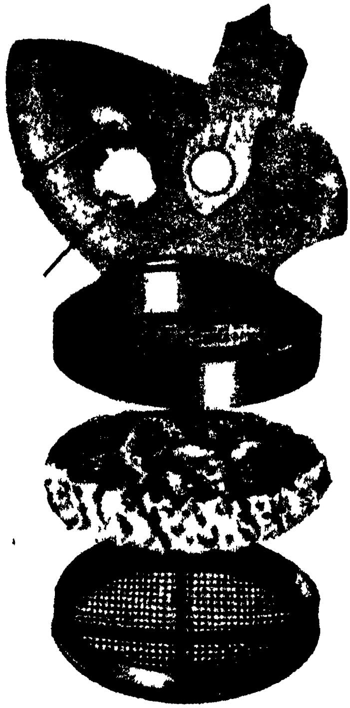


FIG. 5 (*b*).

is not done in a closed container the amount of irritating dust escaping into the air is much greater, and the use of a mask, as described above, becomes still more essential.

We would strongly advise all farmers in Scotland to disinfect their seed oats in the coming year. Our work has made it clear that the disease is common throughout the whole country. As a result of the wet summer experienced in 1931, there is every probability that the contamination of seed will be more serious than it would have been as a result of more favourable conditions during the pre-harvest months. The earlier in spring the oats are sown the greater is the need for disinfection, as the primary phase of leaf stripe is most virulent during cool weather. The actual cost of disinfection of seed oats by Ceresan varies from

about 9*d*. to 1*s*. per acre, according to the variety employed and rate of seeding. Where dusting of the grain has been practised, we cannot too strongly emphasise the necessity of reducing the rate of seeding by 1 to 2 bushels per acre from that normally employed with untreated seed.

STUDIES IN THE PREVAILING DISEASES OF POULTRY.

D. C. MATHESON, F.R.C.V.S.,

Department of Poultry Diseases, Royal (Dick) Veterinary College, Edinburgh.

DURING the past six years the writer has had under observation for a period of twelve months each six high grade flocks consisting of from 400 to 600 pullets assembled from various parts of Great Britain; housed under first class conditions; scientifically fed and controlled by skilled management. The birds came under observation in October of one year and remained under observation till September of the following year. Each bird was examined before being allowed to enter the flock; any bird not in apparently good health was rejected. The comparatively small number in the first flock was due to the rigorous eliminating examination, which, however, was justified subsequently by the improved type of bird that was presented for acceptance. The birds were arranged in groups of six, each group having a separate house and a separate grass run. The breeds represented included:—White Leghorn; White Wyandotte; Rhode Island Red; Ancona; Black Leghorn; Light Sussex; Buff Rock; Barnevelder; Barred Rock; Black Minorca; Exchequer Leghorn, and Cuchoo Leghorn. Every bird dying during the period of observation was submitted to post-mortem examination in the writer's laboratory. The time is divided into twelve periods of four weeks each from the commencement of the observation on October 15th in any year. The data upon which the present article is based were obtained by a scrutiny of the post-mortem and other records of these flocks.

The number of pullets under observation was 3,306, and the total number of deaths was 230, an average of about 38 birds each year. The total number of diseases recorded was 48; the average number in any year being about 18, and the average number of additional diseases during the period 1925-1930 being about six.

For the purposes of the present article the writer selects as prevailing diseases those which occurred during each of the years of observation. These were: (1) tuberculosis; (2) impaction of some portion of the alimentary tract; (3) tumours; (4) fatty degeneration of the liver, often with a terminal hæmorrhage; (5) impaction of the oviduct. Further support of the contention that these are prevailing diseases is afforded in a report by the

writer to the Third World's Poultry Congress[1] and based upon a scrutiny of his laboratory records for a period of thirteen years, and including fowls of all grades drawn from various parts of Great Britain. Each of the above diseases appears in the list of causes of death among the fowls examined.

In an endeavour to discover why these diseases are prevalent, the writer has examined the pen records of the flocks, and the results may be considered after explaining that the term "disease" in this connection refers to any disease and not simply to the prevailing ones as defined above. To prevent misunderstanding it may be well to explain that the term "pen" in the following discussion refers to the enclosure consisting of a fowl house and grass run reserved for each group of birds.

Pen Records during the Six Year Period :—

Pens in which no case of disease appeared	20
Pens in which disease appeared once only	26
Pens in which disease appeared more than once ...	54
Total number of pens in which disease appeared ...	173
Average number of pens in which disease appeared	28·8
Average increase in the number of pens affected during the period 1925-1930	2·4
Average number of new pens affected during the period 1925-1930	5
Pens having more than one case of the same disease in one year	3

No pen has had a case of disease every year. No pen has been affected more than four times. No pen has been affected for more than three years in succession with one exception (pen N), and even then the diseases were not the same.

We may now briefly discuss the prevailing diseases in relation to the pen records and to the time periods :—

1. *Tuberculosis*. 22 cases.

The disease never recurred in the same pen in any of the following years. Generally one case only appears in the same pen, that is, estimating the number of cases by the number of deaths; the one bird may infect its pen mates, but death from tuberculosis does not usually come to them during the year of observation. It was not until the last two years that more than one case occurred in one pen. Even when the disease has appeared in subsequent years in adjacent pens or in pens in proximity, an average interval of more than two years separates the cases. Tuberculosis was the only disease to show two or more cases in one pen in one year on two successive occasions. Tuberculosis is not a seasonal disease, but the finer months of the year show a proportion of cases.

The birds which died from tuberculosis during the period of

[1] Matheson, D. C. (1927). "Preventable Losses from Poultry Diseases." *Proceedings Third World's Poultry Congress, Ottawa.*

observation came from fourteen districts, from the same district and the same place twice, from the same district but not from the same place twice; otherwise the districts were widely separated in Scotland and England.

2. *Impaction of some portion of the alimentary tract—usually impaction of the crop.* (Crop bound.) 20 cases.

This condition shares with three others of the prevailing diseases the distinction of occurring in different years in the same pen. In the case of pen H an interval of at least one year elapsed between the cases, and in the case of pen J an interval of three years occurred. There was never more than one case of the disease in the same pen in one year—that fact suggests that the trouble lay with the bird concerned and not with the pen. Periods 2 and 10 have the highest incidence with three cases each during the six years. Only twice were there two cases in the same period during the six years, viz. two in period 8—1928-29, and two in period 10—1929-30. As the highest incidence of cases occurred in two such widely separated periods as period 2 (Nov. to Dec.) and period 10 (June to July), it does not appear as though the condition of the grass run had much to do with the cases; moreover the pen mates of the affected bird remained healthy.

3. *Tumours.* 28 cases.

Quite frequently the tumours are malignant in character, but for the sake of brevity, in the present connection, the malignant and the so-called benign growths will be dealt with together. Tumours occurred in birds in three distinct pens in different years. No other disease occurred similarly in more than two pens. In the case of pen R the interval between the cases was at least seven months. In the case of pen F the interval was at least twelve months, and in the case of pen X the interval was four years. The twelfth period shows the highest incidence of cases, viz. 7, and the eighth period shows the next highest incidence of cases, viz. 4. These facts point out the importance of tumours among fowls, and suggest that the age and biological economy of the fowl are important factors but do not suggest than any infection is spread from the pen.

4. *Fatty degeneration of the liver frequently terminating in rupture and hæmorrhage.* 12 cases.

Two pens, K and D, showed the disease among the birds confined therein in more than one year, but in the case of pen K an interval of two years elapsed between the cases and in the case of pen D an interval of three years elapsed. These details suggest that the cases had nothing to do with either the pens or with each other from the ætiological point of view. The highest case incidence of the disease is in the twelfth period, but cases are almost as common during the sixth, seventh and eighth periods,

which facts suggest that the period has little or nothing to do with the incidence of the disease beyond the possibility that as the bird grows older it becomes more liable to the disease.

5. *Impaction of the oviduct.* 17 cases.

Impaction of the oviduct shares with tuberculosis the distinction of having occurred more than once in a pen in one year. Pen T had two cases of impaction of the oviduct in one year, but four out of the six birds in this pen died from various causes that year. Impaction of the oviduct occurred in pen O on two occasions but an interval of four years separated the cases, which fact suggests that they had nothing to do with each other. The eleventh period showed the highest incidence of cases, having a case in five out of the six years of observation. Cases tend to occur towards the close of the observation period.

It will be noticed that only five diseases are prevalent in the sense of the above definition, and only one of these (tuberculosis) is associated at the present time with an organism. The investigation shows that tuberculosis is prevalent in the sense of our definition because the affected pullets bring the disease with them to the observation ground, not because they contract it from the pen or soil. With the exception of tuberculosis and possibly of tumours, it would appear as if the stamina, constitution or conformation of the individual bird were primarily responsible in the case of the prevailing diseases; not the feeding, housing or character of the grass run. Tuberculosis is of course an infectious disease. Stamina and constitution are important, but in this disease we have a germ to deal with, not at the moment obvious in connection with the other conditions studied.

Acknowledgments are due to Mr. J. E. Wilson, B.Sc., M.R.C.V.S., of the above Department for assistance in connection with the post-mortem examinations; and to the Department of Agriculture for Scotland for permission to publish the paper, which is based upon an analysis of the excellent reports published by the Department in connection with the Scottish Egg-Laying Tests.

INSECT PESTS.—No. XIII.

R. STEWART MACDOUGALL, M.A., D.Sc.

TWO-WINGED FLIES—(*continued*).

IN discussing the Gall midges (Cecidomyidæ) in our last article we had for purposes of space confined ourselves strictly to those species which attack agricultural crops. Had one gone further, then a serious pest on pears would have been described, viz. the Pear midge (*Contarinia* or *Cecidomyia pyrivora*). The minute larvæ of this insect are found several or

a number together in the young fruits resulting in a serious diminution of the fruit crop.

Passing from the gall midges we come to

The Crane Flies (Family *Tipulidæ*).—This is a family of fairly large to large flies, though none of our British species can match in size a Chinese species which has a wing-spread of 4 inches.

Everyone is more or less familiar with the big, sprawling, awkward-looking fly known as Daddy Long Legs, whose stilt-like legs break off so easily. The adult fly is not harmful to crops; it is the larva or leather-jacket which does the damage.

All species of Tipulid larvæ are not destructive to agricultural crops, and work at the group is still necessary in order to sift out the harmful forms from the large number of Tipulid species. In different parts of the country, in different seasons and in differing habitat—marshy ground, garden soil, clay soil—different species may be in the majority. For example, of specimens collected by me in Perthshire some time ago *Tipula oleracea* was the commonest, but I also found *T. paludosa* and *Pachyrhina histrio.* Pupæ of *histrio* were found in the last week of June from which in the same week adults emerged. *T. oleracea* larvæ collected in late June and placed on turf in my laboratory went on to complete their development, adults coming away in late July and in August. In an earlier year, from *T. oleracea* larvæ collected in Aberdeenshire in the second last week of June the first adults came away on July 25. Further, in late July, August and September there were collected, in the flying stage, large numbers of *T. oleracea*, *T. lateralis* and *T. confusa.* Theobald,[1] in addition to *oleracea, paludosa* and *lateralis* names *Pachyrhina maculosa* as a very abundant and troublesome species in Britain, as also *T. quadrifaria*. Dr. Rennie[2] states that the commonest species in grass and corn land, in Aberdeenshire and neighbourhood, is *T. paludosa;* Rennie found the larvæ of *histrio* in the fields in comparatively small numbers, and he took in the winged stage in the district surrounding Aberdeen, *T. varipennis*, *T. gigantea* and *T. lutescens.*

While in Scotland it was thought that *T. paludosa* and *T. oleracea* were perhaps the best known species, there often arose the difficulty of clearly distinguishing between these two species. Morrison[3] found separating characters in the male genitalia, but it was left to Britten[4] quoted by Oldham[5] to point out that there was a third related British species which perhaps was the cause of some of the confusion, viz. *Tipula czizeki.* Britten, to whom we are indebted, has cleared up the confusion and given

[1] First Report on Economic Zoology. British Museum. 1903.

[2] "On the Biology and Economic Significance of *Tipula paludosa*," in the *Annals of Applied Biology*, Vol. II, No. 4, 1916, and Vol. III, No. 3, 1917.

[3] "Species determination of two common Crane Flies, *T. paludosa* and *T. oleracea*," in *Proc. Roy. Phys. Soc.*, Vol. XXI, Pt. I, by T. A. Morrison.

[4] H. Britten, F.E.S., in *The North-Western Naturalist*, Vol. I, No. 2.

[5] "On the Final Larval Instar of *T. paludosa* and *T. lateralis*," by John N. Oldham, B.Sc., Ph.D., in *Proc. Roy. Phys Soc.*, Vol. XXI, Pt. 5.

characters which enable the three related species to be distinguished thus :—

1. Antennæ 12 jointed. Female[1] with wings longer than abdomen.

a. Eyes almost touching beneath the head; basal joints of antennæ pale. *T. oleracea*.

b. Eyes widely separated beneath the head; antennæ wholly dark. *T. czizeki*.

2. Antennæ 13 jointed. Female with wings shorter than abdomen.

a. Eyes widely separated beneath the head; antennæ pale at base. *T. paludosa*.

The Crane fly species troublesome to the farmer are well-known enemies chiefly of grass land and broken-up lea, but the damage of their larvæ or leather-jackets is not confined to cereals

FIG. 1.—Leather-jackets.

and grasses but is often severe on cruciferous garden and allotment vegetables, e.g. turnips, potatoes, peas and beans. Tipulid larvæ are also destructive at the roots of forest crops which are in the seedling and nursery stage.

Life history and habits.—*T. oleracea* or *T. paludosa* may be taken as more or less typical. The adults are found flying in summer and autumn. The long legs, awkward-looking enough as the daddy endeavours to scramble up a window pane, are of service as the insect makes its way between grass blades at the time of egg-laying, with the abdomen hanging vertically downwards, the tip every now and again reaching and entering the soil or cracks in the soil. The eggs are small, elongated oval, and shining-black to dull black; several hundreds can be laid by one female. Rennie describes *paludosa* as polygamous and promiscuous. The adult life is short. The abdomen of the male ends in a knob; that of the female is pointed; if one examines the pointed end with a hand lens four horny-pointed projections

[1] The abdomen of the male is swollen or knobby; the abdomen of the female is broader and pointed at the ends.

will be seen, the upper two slenderer, the lower two broader; all four can be brought together for the laying of the eggs.

The eggs are laid just below the surface of the soil; they hatch in a fortnight. The young leather-jacket is pale sandy-coloured, and more bristly in appearance than the better known older grub. Specially characteristic of the young larva are two tufts of curved bristles carried by the last joint. The young larva feeds on humus and rotting plant matter and grows into the well-known grey, or brown-grey, or earth-coloured and tough-coated leather-jacket. (Fig. 1.) The head is retractile within the next joint of the body. If one looks closely at the head while it is being thrust slightly out, horny toothed jaws will be seen; one may test these by rubbing a lead pencil against them or they can be felt if one takes a leather-jacket up into the open hand and allows it freedom of movement, when the looser skin between the fingers may be caught in the jaws of the grub; the skin is not broken or wounded; only a very slight nip is felt. Still closer examination, under magnification, will reveal, on the head, a

FIG. 2 —Leather-jacket at root of plant

pair of minute sensory antennæ. On the upper half of the hind face of the last joint are two dark-coloured spiracles or breathing organs, surrounded by six conical papillæ; the lower part of this hind joint is marked by the hind opening of the alimentary canal; this pore, surrounded by fleshy lobes, allows the passage of the excrement.

The leather-jacket is legless but can move on the surface of the grass, and in the soil, partly by aid of bristles and partly by gripping with its jaws and pulling.

The larvæ, hatched in summer and autumn, feed over the rest of the year and into the next spring and early summer; there is considerable variation, according to actual time of egg-laying and hatching, depending too on the amount and nature of the food supply and the weather conditions. On the average we may say that nine months of the year are passed in the leather-jacket or feeding stage, this nine months including the winter period. In severe frost the larvæ may go deeper for protection, and become quiescent, interrupting their feeding until the environment becomes more favourable; feeding may go

on in winter if the weather is open. The point to notice is that frost is not fatal to the leather-jacket, which, like other larvæ that pass the winter as such, is fitted to resist the cold. Drought and sun are more dangerous for the larvæ, and especially in such conditions is mortality great when the larvæ are young.

The leather-jackets feed at the roots of plants or feed, hidden or half-hidden, in ploughed-in turf. (Fig. 2.) At night and in moist muggy sunless mornings the leather-jackets come to the surface, where they may be found feeding on young above-ground shoots and leaves; they tunnel again into the soil at will.

When full-fed the leather-jacket pupates in the soil. The pupal stage lasts about a fortnight. The pupa is interesting. On the abdominal joints there is a series of projecting spines, greatest in number towards the end of the abdomen. In order that the adult flying Daddy Long Legs shall escape from its surrounding sheath without having to attempt the impossible task of making its way unharmed through the soil, the pupa by aid of the abdominal spines wriggles to the surface and remains erect, with the head and fore

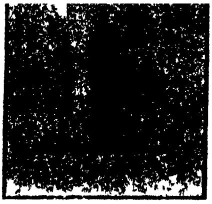


FIG. 3.—Front end of pupal sheath projecting above soil; the adult crane fly has issued.

part of the body projecting above ground. Two small respiratory horns are present at the head end, and by means of these air is conveyed from the outside to the enclosed fly preparing for exit. In due course the pupal sheath splits at the thorax, and the daddy issues. The empty pupal skins are often to be seen standing up out of the soil and showing quite plainly the respiratory horns and also the slit by which the daddy escaped. (Fig. 3.) Pairing takes place soon after exit, and a new egg-laying follows.

Crane flies may be found in flight until the first frosts of autumn.

Control.—Grass and clover are practically certain to be used for egg-laying by Tipula and the less close-grazed the pasture the greater the likelihood of the egg-laying. The sooner in late summer and early autumn the ploughing can be done the less the invitation to the daddy to lay her eggs. But to very early ploughing there are disadvantages and difficulties. The ground may be too hard for ploughing; there might be considerable loss in grazing for cattle and sheep; further, other farming operations may need attention. In absence of early ploughing the pasturing of sheep is advantageous not only because it makes

for close grazing but also because the egg-laying Crane flies are disturbed and trodden under foot.

One of the warnings given, of a crop being likely to suffer from "the grub," is unusual numbers of the flying Crane flies in the preceding summer, late summer, and autumn. This does not really need special and trained observation and one should not be too busy to take notice of it. In such a case the roller applied at the proper time is most useful—e.g. rolling on cold still days when the adults are sluggish and sheltering in the grass will kill many.

Rolling can also usefully be practised against the grubs, not only by killing grubs when at the surface, but also by compacting the uppermost soil-layers and so rendering active movement by the grubs difficult. Such rolling would be specially advantageous at the time of the germination of the seed, and the breaking through the ground of the young plants. For such killing of grubs, the rolling should be in the warm muggy evening or in the morning in sunless weather, when the leather-jackets are on the surface. Rennie[1] wrote :—"I have observed that when the soil in experimental boxes was packed tightly, the grubs remained for days in the same position. Delay of this kind is of some importance in spring in giving the young plants time for growth, at the most critical time in relation to grub attack. Further, since the changes of temperature of the soil between night and day have the effect of loosening the soil around the plants, this tends to give freer access to the roots for the larva. Close packing of the soil around the young plants in the morning is therefore of special value when grubs are abundant in the soil."

Weather conditions really play an important part in determining whether the daddy will prove a pest. Persistent gales in autumn do much to reduce the numbers of the adults in a swarm year.

The leather-jackets are greatly favoured by moisture and various Tipula species indicate this by the choice of a moist environment for their egg-laying. Absence of moisture and conditions of drought mean a high mortality among the larvæ.

Extremely important, and indeed critical in the presence of grub, is the nature of the weather at the time of germination and brairding. The longer drawn out this is, owing to cold, the more plants are killed by leather-jacket attack. As Rennie says :—"Plants attacked before the period of secondary growth at which the adventitious root system becomes established are liable to be killed. The grub is active at a later stage, but although it damages it does not kill the plants. Growth continues and the capacity to tiller is not destroyed." The relation of this to the possible advantage of late sowing in a cold backward district or season is evident.

The number of leather-jackets in the field is another

[1] "The Crane Fly Grub and the Oat Crop," in *The Scottish Journal of Agriculture* for April 1927.

important factor. In a year when there has been no great complaint of loss due to the daddy the soil has still contained many leather-jackets. All the leather-jackets in an oat field are not feeding on the crop. Rennie showed experimentally that, even in absence of a crop of any kind, the grubs of *T. paludosa* were able to complete their growth on such plant remains as they could find, and it is a common experience of those who have dug for, or looked for, leather-jackets that even in years of loss, if the larvæ were wanted quickly and in numbers, it was easier to collect them in pieces of the ploughed-in turf than to find them at the roots of the crop plant. With good farming and manuring, and favourable weather conditions for the crop, there may be thousands of leather-jackets in the field and the crop yet be safe. Extremely high numbers of leather-jacket larvæ in a field are necessary to produce that overcrowding and consequent competition for food which will result in severe loss of crop, apart from unfavourable climatic factors or slack farming.

The Use of Insecticides.—Till about 1921 there had been little success with any insecticidal treatment against the leather-jacket; treatment with fumigants on the wide scale necessary was too expensive, even if the fumigant were proved to kill. Certain poisons had been considered but their use was risky. In the United States however in 1921 two experimenters noticing that the daddy larvæ came more to the surface than had previously been thought likely, tried a poison-bait of Paris green and bran mash, and with success. Paris green and bran mash had already proved a good ground bait for certain other terrestrial insects both in Canada and the United States. Mr. Hunter, one of the County Organisers of the West of Scotland Agricultural College, found the bait successful against the leather-jacket in a neglected garden,[1] and the practice of so fighting one pest has spread successfully.

There are slight variations in the formula. Packard [2] and Thomson in America used bran 25 lb., Paris green 1 lb., water about 3 gallons, the Paris green being mixed into the bran and water added gradually; applied at the rate of 20 lb. per acre. The West of Scotland formula is "mix 1 lb. Paris green with 30 lb. bran or thirds and moisten the mixture with about 2 gallons of water." This quantity serves for an acre. In preparing the bait an old tub is used. Alternate layers of bran and Paris green are placed in the bottom of the tub until the desired amount has been made up. Stir thoroughly and add water until the mixture is sufficiently damped to cause the Paris green to adhere to the bran and yet be dry enough to sow with ease. Two teacupfuls of treacle, added to the water before it is mixed with the other ingredients, makes the bait more attractive. For convenience a larger quantity of the bait is made, viz. 1 cwt. of

[1] "The Grub Pest and Paris Green as a Remedy." Bulletin No. 103, West of Scotland Agricultural College.

[2] Circular 172, U.S. Dept. of Agric., 1921. By Packard and Thomson.

bran, 12 gallons of water, 4 lb. treacle. The water is added to the tub of bran and the treacle stirred in. The Paris green is next emptied into the tub in four lots and stirred, after each addition, with a shovel. This is the quantity for 4 acres, i.e. the formula per acre remains :—Paris green 1 lb., bran 30 lb., treacle 1 lb., water 3 gallons. In spreading the bait one may find it difficult to get 30 lb. to pan out over a whole acre; therefore some prefer to use 50 lb. bran.

The leather-jackets eat the bait and are poisoned. One had hesitated to try Paris green in this broadcast way because of risk to other animals. It is therefore satisfactory to know that there is " no evidence of birds suffering from picking up poisoned bait or dead larvæ.[1]

There are interesting notes in Continental literature regarding the use of other dressings and baits. Thus in Westphalia[2] much damage was being caused by Tipula larva in pasture. Watering with a solution of ammonium carbonate or with liquid ammonia of 2-4 per cent. strength drove the larvæ to the surface, where they died. A poison bait of Paris green and bran was effective in the absence of rain, and excellent results were also got with sodium fluoride 1 part to 25-40 of bran and with 1 part sodium fluosilicate to 50 of bran.

Where Tipulid larvæ were proving destructive to oats, barley and beet in Schleswig-Holstein[3] in 1928, the presence of larvæ was indicated by watering the soil with 5¼ pints of a 12 per cent. solution of ammonium carbonate per 22 square feet of ground, or 3½ pints of a 4 per cent. solution of sal ammoniac per 22 square feet of ground.

In France a bait that has proved successful is 1 part copper arsenite to 17 parts bran. Moistened with water.

Larvæ confused with the Leather-Jacket.—The larvæ of the family Bibionidæ are not infrequently confused with daddy larvæ, partly because they can be found—among other places—in the neighbourhood of the roots of plants, like daddy larvæ, but also when covered with soil or half-hidden in soil they suggest small leather-jackets. Not so long ago an excellent photograph in one of the leading illustrated weeklies showed a great collection of " leather-jackets " removed from the alimentary canal of a pheasant; but the larvæ were really Bibio larvæ.

When cleared of soil and examined with a hand lens, or better with some higher magnification, Bibionidæ larvæ are recognised not only as differing in appearance from most fly maggots, but as having certain features that make them easy to tell.[4] The body is elongated and covered with a tough outside skin, which, under the microscope, shows characteristic spiny

[1] Bulletin No. 108, West of Scotland Agricultural College.

[2] Abstract in *Review of Applied Entomology*, Series A, January 1927.

[3] *Die Tipula-Schaden des Jahres*, 1928. Landw. Wbl Schles.-Holst., 1929, No. 13, and *Review of Applied Entomology*, Series A, September 1929.

[4] The student who desires information as to the structure of the larva in its various stages and of the pupa should consult the Papers of H. M. Morris in *The Annals of Applied Biology* and *The Bulletin of Entomological Research*.

outgrowths. There is a small head with well marked mouth-parts in which the mandibles are conspicuous. Twelve joints follow the body, nine of them having spiracles on their sides; the spiracles of the last joint are larger and nearer the upper surface. The larva is legless, but the joints have wart-like projections and backwards-directed spines.

The pupa is mummy-like; it is found in the soil under cover of a cell or chamber of earth. Bibio larvæ are found, not singly, but a number together, and accordingly one may come across nests of pupæ, each, however, in an earthen cell of its own. The pupæ do not have the prickles described earlier as possessed by the leather-jacket pupæ.

There is considerable difference of opinion as to the economic importance of Bibionidæ larvæ. The literature contains numerous examples of damage, at the roots of garden and agricultural crop plants, stated to be due to these larvæ. On the other hand there is a body of opinion that regards the larvæ as chiefly scavengers.

It is certain that the larvæ are often introduced to field and garden in manure. Larvæ have come to me from cow manure; in peat used for potting purposes; in the soil of an old chrysanthemum bed; in a turf from a poultry-farm; from a bowling-green; in the soil at the roots of potted carnations and other plants; and from ordinary garden soil.

The adult flies are interesting as showing a colour difference between the males and the females, and although they are harmless—indeed they are useful as agents in pollination—they often excite alarm and fear for the future fruit crop by their appearance, in May for example, in thousands round and among the blossom of apple and other trees. In one case from the south very old and rotten cow manure had been carted to a field in autumn, and in the following May the adult flies swarmed on the blossom in the orchard. Uneasiness, in another case, attended the appearance of swarms among raspberries in Perthshire.

The species that came to me at different times, for determination, were the Fever Fly (*Dilophus febrilis*), St. Mark's Fly (*Bibio marci*), St. John's Fly (*Bibio johannis*), and *Bibio hortulanus*.

In a package from the south of England containing *B. hortulanus* my correspondent wrote that his attention had been specially called to the flies by the great excitement amongst 20 or 30 starlings in his garden. The starlings were catching adults in the air and also picking them off the ground. The date was May 13 and the flies were busy mating. The two sexes of *B. hortulanus* are easy to distinguish, the males being black and the females red. The starlings were particularly after the larger females, which were full of eggs.

The Beet and Mangold Fly (*Pegomyia betæ*).—Leaving the Bibionidæ and passing to flies whose larvæ mine or tunnel leaves, we choose as an example the Beet and Mangold Fly, partly because of the growing importance of sugar-beet, the increased

acreage of which is certain to make the work of this fly more familiar. From more than one area in Scotland requests have come for information as to this enemy of the beet and mangold.

The adult flies are dark ashy-grey and bristly, and otherwise to the ordinary observer suggest in shape and size a housefly The flies appear in April from puparia that have wintered in the soil. The female lays her eggs—white in colour— on the under

FIG. 4 —Young leaves of sugar beet mined by the larvæ of the Beet and Mangold Fly

side of the sugar-beet leaves in clusters varying from a few to double figures By a week the eggs can have hatched into legless maggots, which bore through the epidermis of the leaf into the softer, middle part of the leaf whose green cells normally act as sugar makers The larvæ mine in the leaf, destroying these cells and giving rise to dead, pale or discoloured patches (Fig 4) There can be, as a result, great reduction in feeding, i e in sugar-making, area and, in the case of young plants, the complete destruction of the leaf If one holds an attacked leaf up to the light, one that shows the pale blotches, the mining maggots and

their pellets of excrement can be seen. In a fortnight's feeding the maggots may be full-grown.

The full-grown larva is yellowish in colour, measures about one-third of an inch in length, and is a typical maggot with pointed head-end, carrying triangular mouth-hooks and a blunt or square-cut hind-end.

The larva, on completing its growth, leaves the leaf and enters the soil for pupation. The puparium is found in the surface layers. It is brown and barrel-shaped and somewhat narrower at one end. Occasionally pupation takes place in the spoiled leaf at the place of feeding.

By three weeks the fly is ready to issue and a new generation follows. There is an overlapping of generations, but three generations, from spring to autumn, are likely.

Control is difficult as the larvæ feed protected inside the leaf. Against certain mining maggots in America a spray of 1 part nicotine in 400 parts water killed the maggots and also the newly formed pupæ. More successful was a concentrated solution of nicotine sulphate. In the experiment the plants were few in number and easily reachable for treatment. The Ministry of Agriculture Leaflet suggests as possibly effective in killing the young maggot (perhaps it might help also to keep off the flies) soft soap 1 lb., paraffin 1 pint, nicotine (95 per cent.) $\frac{3}{4}$ oz., water 10 gallons, made thus:—dissolve the soft soap in 1 to 2 gallons of boiling water. Emulsify the paraffin in a hot soft-soap solution by taking up the paraffin in a garden syringe, a syringe-full at a time, and squirting it violently into the soap solution. Dilute to 10 gallons by the addition of 8 to 9 gallons of water as required. Add the nicotine and stir well before using.

The most serious danger in attack is to young plants. The most favourable growing conditions possible, with, if necessary, a forcing manure, may assure the plant's growing away from the attack.

A very interesting feature in connection with this fly is that there appear to be biological races or biological species, one race having become so accommodated to one species of food plant that it will not lay on the plant favoured by the other race and *vice versa*. Two such races here are distinguished as *Pegomyia hyoscyami*, which attacks as favourite food plants certain Solanaceous species; and *Pegomyia hyoscyami* var. *betæ*, which favours Chenopodiaceous plants like beet and mangold.

Dr. A. E. Cameron,[1] who worked out the life history of *P. hyoscyami* on Belladonna—a plant of the order Solanaceæ—could not induce ripe females bred on Belladonna to lay on mangold nor ripe females reared on mangold (Chenopodiaceæ) to lay on Belladonna. In past years I found the Belladonna race or variety of the insect abundant on Belladonna which was being grown for commercial purposes in the neighbourhood of Edinburgh.

[1] "A contribution to the knowledge of the Belladonna Leaf Miner (*Pegomyia hyoscyami*), its Life History and Biology." In *Annals of Applied Biology*, Vol. I, No. 1, May 1914

LENTIL MEAL AS A PROTEIN SUPPLEMENT IN PIG RATIONS.

A. W. Menzies Kitchin, M.A., B.Sc. (Agr.),

School of Agriculture, Cambridge.

Lens esculenta, the common lentil, is an important member of the grain leguminosæ and is widely grown throughout Europe, Asia and Africa. It is cultivated in most Western European countries, in Egypt and Palestine, in North Africa, in South America, in Persia and India, and finally in Russia, where the Soviet crop occupies approximately half the world acreage under lentils. Egypt and Spain are the next most important producers, while Russia, Spain, Egypt, Chili, Abyssinia, Turkey, Western Asia and India are exporting countries. The genus Lens is broadly divided into two main groups, mainly differentiated by seed size, and for this reason they are known as (*a*) the Macrosperma and (*b*) the Microsperma, or the large and small seeded varieties. The latter are used mainly as forage crops and therefore consumed in the country of origin, but the former are exported to this country, where at the time of writing they can be obtained at a price between £6 and £7 per ton. Although lentil meal has been recognised since prehistoric times as a valuable human food, little reference is made to it in the literature of animal nutrition—due probably to the fact that hitherto the grain has not been available in sufficient quantity or at a price likely to encourage its use in animal feeding. Recent consignments, however, available after grinding at the price quoted above appear to offer a valuable and cheap source of protein suitable for pig fattening.

The following experiment was therefore designed to determine the value of ground lentils when used in partial replacement of fish meal in a ration for fattening pigs.

Composition.—Although the composition of lentils is subject to considerable variation depending on the climate in which they are grown, it appears to be generally similar to that of beans. Wood gives the following analysis for the two grains. Fish meal has been added for comparison :—

	Dry matter.	Protein.	Fat.	Carbohydrate.	Cellulose.	Ash.
Lentils	86·0	25·5	1·9	52·2	3·4	3 0
Beans	85·7	25·4	1·5	48·5	7·1	3·2
Fish Meal	87·0	55·6	4·4	2·1		24·9

From these figures it might be expected that on account of its low fat content the use of lentil meal in pig feeding would tend to produce a firmer carcase than would the use of fish meal. But as it contains approximately 50 per cent. less protein, two parts of lentil meal would be required to replace one part of fish

meal in the ration. Moreover, as fish meal contains 24·9 per cent. ash—mainly composed of lime and phosphoric oxide—while lentils contain only 3 per cent., a mineral addition is necessary when using the latter meal. In the experiment this addition took the form of 3 : 1 mixture of ground limestone and salt fed at the rate of 1 lb. for every 100 of meal consumed. Ground mineral phosphate was omitted as it has been previously demonstrated by experiment that sufficient phosphate for optimum growth is furnished by the ash fraction of a cereal ration.

In view of the above facts it was decided during the first part of the experiment to replace 50 per cent. or five parts of fish meal by ten parts of ground lentils, and when the experimental animals reached an average weight of 140 lb. to leave off feeding fish meal and to supply the total protein requirement in the form of lentils.

The rations were made up as follows :—

	Group I.		Group II.	
80-140 lb.				
	Barley meal ..	65 parts	Barley meal	65 parts.
	Middlings ..	25 ,,	Middlings ...	20 ,,
	Fish meal ...	10 ,,	Fish meal ...	5 ,,
			Lentils ...	10 ,,
			Minerals ...	1 part.
140 lb. to slaughter.				
	Barley meal ...	80 parts.	Barley meal	80 parts.
	Middlings ..	15 ,,	Middlings ...	10 ,,
	Fish meal ...	5 ,,	Lentils ...	10 ,,
			Minerals ...	1 part.

Method.—Twenty pure bred Large White pigs were divided into two groups so that as far as possible each group was comparable as to age, sex, weight and breeding. Both groups were kept under similar housing conditions in well lit piggeries with concrete floors and dunging passages, and were fed on a standard ration during a preliminary period of four weeks during which both groups were wormed and inoculated against swine erysipelas. At the beginning of the fifth week experimental rations were fed. The experiment lasted ten weeks during which both groups were wet fed to appetite twice daily. No green stuff was allowed but water was available in both pens. Both groups were weighed weekly at 8 a.m.

When the heaviest pigs in each group reached a live weight of approximately 200 lb. they were sent to the St. Edmundsbury *Bacon Factory, Elmswell, Suffolk, where they* were weighed on arrival, slaughtered, weighed dead, and measurements taken by side length and depth of back fat at the thinnest and thickest points. The carcases were then graded. The remaining pigs in each group were continued on the experimental ration until they reached bacon weight (200 lb.), when they also were sent to the factory.

The results of the ten weeks' feeding trial are given in

Table I, while Table II contains the average group weights at the factory, carcase measurements and grading.

TABLE I.

Averages.	Group I.	Group II.
Initial live weight	81·3	81·8
Final live weight	188·7	195·4
Live weight gain in 70 days	107·4	113·6
Average gain per day...	1 53	1·62
Lb. per lb. live weight gain	4·5	4·36
Lb feed consumed per day	6·91	7·06
Cost of gain per lb.	3·89*d*.	3·51*d*.
Health	Good	Good.
No. of pigs averaged	10	10

TABLE II.

Group	I.	II.
No. of pigs in group	10	10
Weights.		
Live weight on farm ... ... lb.	207·0	260·1
Live weight at factory ... ... lb.	205·0	202·7
Dead weight—Cold ... ... lb.	156·0	154·7
Measurements.		
Length ... ... inches	30·6	30·4
Thinnest back fat ... ... inches	1·07	1·20
Thickest back fat ... ... inches	1·97	1·97
No. of Grade I carcases	10	8
No. of Grade II carcases	0	2
Carcase quality	Excellent.	Excellent. Fat firm.

Results.—During the experiment the pigs receiving lentil meal and minerals (Group II) were more uniform and made better gains than those in Group I receiving fish meal. This is emphasised in Table I. Over a feeding period of 70 days the average gain per pig in the fish meal group was 107·4 lb., while the similar figure was 113·6 in Group II, a difference of 6 lb. per pig. Moreover throughout the experiment Group II (lentil) pigs had keener appetites and remained in better condition.

In respect of meal consumption per lb. live weight gain there was a slight but not significant difference in favour of Group II, and the main advantage of the lentil meal appeared to lie in a higher daily consumption which resulted in a slight increase in growth rate. There was little to choose between the carcases of the two groups at slaughter. Group II carcases were of excellent quality and were favourably commented on by the factory management.

Feeding Cost.—It is, however, when we come to discuss the experiment in terms of cost that the most marked differences are apparent. The average price per cost of the feeds used during the éxperimental period was :—

Barley meal	7*s*. 6*d*.
Middlings	6*s*. 3*d*.
Lentil meal	7*s*. 0*d*.
Fish meal	18*s*. 6*d*.

and in the 70 days' feeding the groups consumed :—

	Group I.			Group II.		
	cwt.	qr.	lb.	cwt.	qr.	lb.
Barley meal	31	1	8	32	0	10
Middlings...	8	2	13	6	2	6
Fish meal...	3	0	20	1	0	8
Lentils		...		4	1	18
Total Cost	£17, 8*s*. 6*d*.			£16, 12*s*. 3*d*.		

Nor is this the complete picture. In 70 days 7 pigs in Group II had reached the required weight of 200 lb. and were ready for slaughter, but only 4 pigs in Group I had reached this weight. The remaining pigs, 3 in Group II and 6 in Group I, were therefore fed for a further period of three weeks, during which period they incurred an additional feeding cost of 66*s*. in Group I and 29*s*. 4*d*. in Group II. The total meal charge therefore from the beginning of the experiment till slaughter was £20, 14*s*. 6*d*. in Group I and £18, 1*s*. 7*d*. in Group II, or a difference of £2, 12*s*. 11*d*. in favour of lentil meal; or in other words, an additional profit of 5*s*. 4*d*. per pig in the lentil meal group.

Conclusion.—From these results it would appear that 10 parts of lentil meal in conjunction with a one per cent. mineral supplement of 3 parts ground limestone and 1 part salt can be used to replace 5 parts fish meal in the rations of fattening pigs without any decrease in live weight gain and with a considerable reduction in feeding cost. These results indicate that as long as lentil meal remains at its present price of £6, 10*s*. per ton its use in pig feeding is to be encouraged. Although we have not had an opportunity of carrying out further experiments with lentil meal, the composition of the grain and the keenness with which the ration was eaten throughout the experiment appear to justify the belief that 20 parts of lentil meal and minerals could be used as a complete substitute for fish meal in a pig fattening ration provided that fish meal is fed until the pigs have reached an average live weight of approximately 80 lb.

The following article has been contributed by Messrs. J. A. Crichton and W. M. Allcroft, Duthie Experimental Stock Farm, Rowett Research Institute, Aberdeen.

Feeding Tests with Bran and Linseed Cake.

The quota system introduced with regard to wheat is likely to be followed by an increase in milling in this country, with a consequent increase in the amount of wheat offal available for feeding. This makes the question of the feeding value of wheat offal of special interest at this time.

It has always been recognised that bran has a laxative and tonic value, and it is frequently used as a special feed for horses and cattle after parturition and in cases of sickness. The modern work on nutrition would also suggest that wheat offal should have special health qualities. The greater part of the mineral matter and also the valuable vitamin B of the wheat is contained not in the flour but in the wheat offal. Unfortunately, except in research work on vitamins with small animals, very few tests have been made comparing the value of bran with other feeding stuffs. In this country, Bruce at the Edinburgh College carried out some tests, published in 1912, in which the relative value of bran and linseed cake was compared for feeding beef cattle. The results led him to believe that the feeding value of bran had been under-estimated. In the Scandinavian Feed Unit System, in which the feeding value of meals are based upon practical feeding experiments with dairy cattle and swine, 11 lb. of bran is given as equivalent to 9 lb. of linseed cake. From the starch equivalent values, however, according to Kellner's standards, which are based upon chemical analysis, 11 lb. of bran is equal to only 6·32 lb. of linseed cake. This difference in the assessment of the nutritive value and properties of bran suggests that it has a higher feeding value than is indicated by the conventional method of chemical analysis.

In some recent feeding experiments with beef cattle on this farm, bran was used in certain groups and linseed cake in others, and in view of the present interest in the subject it is considered worth while abstracting from the experimental data the figures comparing bran and linseed cake.

The animals used in the experiment were Aberdeen Angus cross cattle, 7 to 9 months old on 13th November 1930, the beginning of the experiment. They were specially obtained for this trial and, being bought in the open market, their previous nutritional history was not known with certainty. As far as possible the animals were arranged to have the groups comparable. There were four groups, each of 10 cattle, two groups being fed intensively, the other two groups being store fed. The basal ration common to all groups consisted of turnips, straw, silage and hay. The concentrate mixtures fed were :—

Linseed Cake Ration.		*Bran Ration.*	
Maize (ground) ...	8 parts.	Maize (ground) ...	8 parts.
Barley (ground) ...	8 parts.	Barley (ground)	8 parts.
Linseed cake meal	9·2 parts.	Bran	16 parts.

From the analyses of the feeding stuffs 9·2 lb. linseed cake meal gave the same starch equivalent as 16 lb. bran.

Groups fed intensively.—The concentrate mixtures were fed at the rate of 5 lb. linseed cake mixture and 6 lb. of bran mixture at the commencement, rising to 7·9 lb. and 10 lb. respectively by 8th April, at which level the concentrate feeding was maintained to the end of the experiment. On 30th April the animals were put out to grass for three hours per day with no change in the amount of concentrates fed, but the amount of roughage was reduced. By the 26th June a number of the animals were fat and were sold. By the 4th July, eight out of the bran group were considered finished, whereas only four out of the linseed cake group were at the same advanced stage, showing that the bran fed cattle had finished quicker.

With regard to appearance, throughout the latter part of the test the bran group looked better than the others, being firmer to handle and being the group invariably commented on by visitors as being the best cattle.

The following table gives the essential data for groups 3 and 4, which were intensively fed :—

TABLE I.

Intensive Feeding.

	GROUP 3, receiving the linseed cake mixture.	GROUP 4, receiving the bran mixture.
Average initial weight 13th Nov. 1930 ..	540 lb.	540 lb.
Average weight when grazing began 28th April 1931	786 lb.	805 lb.
Average weight 23rd June *	838 lb.	865 lb.
Total production of live weight	3564 lb.	3742 lb.
No. of cattle days on feed	2530	2366
Gain in lb. per day	1·444	1·581
Feed cost per lb. of gain	6·22*d.*	5·75*d.*

* The last comparable weighing before either group was broken up by the sale of any of the animals.

Groups store fed the first winter.—The two groups being store fed were on the same basal ration and on the same concentrate mixtures, but for the first winter, up till they went to grass, they were limited to 1·6 lb. of linseed cake mixture and 2 lb. of bran mixture respectively. At grass they received no supplementary feeding. On August 25th they were brought in and fed to finish, the same concentrate mixtures being used at the rate of 4 lb. of linseed cake mixture and 5 lb. of bran mixture in groups 1 and 2 respectively.

The data up till the close of the experiment on 13th October 1931 are given in Table II.

TABLE II.

Store Feeding.

	Group 1, receiving the linseed cake ration.	Group 2, receiving the bran ration.
Average initial weight 13th Nov. 1931 ...	541 lb.	539 lb.
Average weight when grazing began 28th April 1931	618 lb.	628 lb.
Average weight when grazing ended 25th August 1931	818 lb.	819 lb.
Average weight 22nd September 1931 * ...	872 lb.	871 lb.
Total production of live weight	3693 lb.	3985 lb.
No. of cattle days on feed	3564	3561
Gain in lb. per day	1·036	1·119
Feed cost per lb. of gain	5·39*d.*	5·04*d.*

* The last comparable weighing before either group was broken up by the sale of any of the animals.

Discussion and conclusions.—It should be pointed out that the numbers of animals in these groups are too small to allow definite conclusions to be drawn, especially in view of the fact that all the animals had not an identical nutritional history and consequently there were considerable individual differences within the groups. The only conclusion which we are warranted in drawing is that on the whole the bran fed groups did rather better than the linseed cake fed groups under conditions when the bran and linseed cake were fed in starch equivalent amounts. The result would therefore lend some support to the view that the feeding value of bran is nearer to the Scandinavian standard, which is based on feeding tests, than to Kellner's standard, which is based on chemical analysis.

It should be pointed out that the results obtained from this test have reference only to the kind of animal used in this experiment and the kind of ration fed. Milk cows, brood sows or very young animals have different food requirements from fattening bullocks, and different results might have been obtained with these classes of animals. Further, in tests with any kind of feeding stuff the results depend upon the extent to which the feeding stuff being tested fits in with the rest of the ration. The value of any feeding stuff when added to a ration depends upon the extent to which it improves the balance of all the constituents and qualities of the ration to which it is added. Hence, in considering the advisability of using bran for any ration, one would need to keep in mind the special qualities of bran, e.g. its comparative richness in fibre, phosphorus and vitamin B, and its relative poverty in calcium and, compared with linseed and other similar cakes, in protein.

In view of the probability of an increase in the amount of bran available for stock feeding, it seems highly desirable that a series of trials be carried out with a view to ascertaining the

best combination of bran with other commonly used feeding stuffs to form perfectly balanced rations for the different classes of farm animals.

Improvement of Permanent Pasture.

THE following report on an experiment on the improvement of permanent pasture carried out at Huntly by Sir Leybourne Davidson and Mr. Alexander Forbes is contributed from the Rowett Research Institute, Bucksburn, Aberdeen.

In the last few years more and more attention has been devoted to the improvement of pastures. The use of better seed mixtures, including wild white clover, more intensive top-dressing and the system of rotational grazing has led to a marked improvement in the feeding value of temporary pastures. A certain amount of experimental work has also been done upon hill grazings and permanent pastures. The late Dr. Smith of Edinburgh carried out some tests to ascertain the effects of the application of fertilisers on patches on hills without any mechanical treatment. These yielded interesting results, and it is to be regretted that this work has not been more developed. At Aberystwyth tests have been carried out to ascertain the effects of ploughing and harrowing and immediately re-seeding without a rotation of crops. This is a method which holds out prospects of improvement in districts where owing to the distance from the farm buildings, or for other reasons, a rotation of crops to obtain good pastures is impracticable. A test of this method made in 1930 on the farm of Kirkhill, taken over by the Hannah Dairy Research Institute, gave most encouraging results. An account of this test is given in the October issue of this *Journal*.

The area under permanent pasture in this country has been increasing since the war and is now over 50 per cent. greater than the area under rotational grazing, which has been decreasing. The improvement of the permanent pastures consequently forms an important item in agricultural practice in Scotland. In the past, the practice has been too often merely to graze from year to year without any attempt at improving or even maintaining the feeding value, with the result that pastures are liable to suffer a steady deterioration.

The present report deals with an experiment which began in 1928 with the object of finding out the extent to which a deteriorated pasture could be improved by direct cultivation and the application of fertilisers without putting the land through rotation of crops.

An 11 acre field on Huntly Lodge was set aside for the test. The grass had been laid down about ten years previously. It had deteriorated so badly that it was considered not worth while spending money for its improvement. The sole of grass was poor. Although inconspicuous plants of wild white clover could be found here and there, the vegetation consisted mainly of Yorkshire Fog and other inferior grasses, moss, weeds and

rushes. The condition was made worse by the fact that it was overrun by rabbits from a neighbouring wood. Although the pasture was so poor, the soil was fairly good. It was a strong clay loam with a lime requirement of over 1½ tons to the acre. Altogether the field was a typical picture of pasture which had deteriorated due to the lack of proper treatment.

The field was first drained where required, and then for the purposes of the experiment divided by fences into six plots, which were fenced to keep out rabbits. In each of these six plots two-thirds of the area had the surface torn up with special grass harrows, the remaining one-third being untreated. The parts of the six plots which had been harrowed received the following treatment :—

Plot 1. 15 cwt. ground lime per acre + 3 cwt. superphosphate.
,, 2. 15 cwt. lime + 3 cwt. superphosphate + a suitable grass seed mixture.
,, 3. 10 cwt. slag per acre.
,, 4. 15 cwt. lime + 10 cwt. slag.
,, 5. 15 cwt. lime + 10 cwt. slag + 4 cwt. sulphate of ammonia in periodic dressings.
,, 6. 15 cwt. lime + 10 cwt. slag + 2½ cwt. Kainit + 1 cwt. sulphate of ammonia.

The harrowing, liming and application of basic slag were carried out in December. The other manures, the grass seeds and the first dressing of sulphate of ammonia were applied in April. In order to ascertain the effect of the application of the fertilisers without mechanical treatment, one-third of the part of each plot which had not been torn up by harrows received the same fertilisers as the part which had been treated.

In the early summer there was in all the plots a remarkable difference between the part which had been harrowed and fertilised and the parts which had been left untreated. The treated parts showed a luscious growth of green pasture, whereas the vegetation on the unharrowed part consisted as before of Yorkshire Fog, low grade grasses, weeds and moss. In plots 1 and 2, i.e. those treated with superphosphate, the growth of grass was earlier. In plots 5 and 6, treated with sulphate of ammonia, the growth was greater, but the vegetation was on the whole ranker, with less clover.

Two bullocks were put to graze in each plot, and in the autumn after the bullocks were taken off, all the plots were grazed with sheep. The bullocks throve well. The following table shows the total increase in weight on the different plots.

	cwt.	qrs.	lb.
Plot 1.	2	3	14
,, 2.	2	3	0
,, 3.	2	2	0
,, 4.	2	1	14
,, 5.	2	3	0
,, 6.	2	1	14

It will be seen that there is little difference in the increase in weight obtained in the different plots, nor was there much in the appearance of the grass to indicate a marked difference in the result obtained with the different fertilisers used.

In the second year all the plots were again harrowed, and the superphosphate only was applied to plots 1 and 2 and the sulphate of ammonia only to plots 5 and 6. So far as the appearance of the pastures went, the result was similar to that of the previous year except that there was a further all round improvement in all the plots, and in plot 2 where the grass mixture had been sown the previous year, there was a better sole of grass with a larger proportion of the desirable grasses.

It was found that two bullocks per plot were insufficient to keep the grass down and it was found necessary to get another group of 13 bullocks, which were moved from plot to plot in rotation for a total period of 25 days. Unfortunately the data were not obtained for the increase in weight of the 12 cattle after 2nd August or for the increase in weight of the 13 bullocks used for rotational grazing, but all the animals throve as well as in the previous year.

In the third year no treatment was applied to any of the plots. The pasture remained quite good, but not quite so fresh and vigorous as in the second year. The main feature of interest in the third year was the untreated parts of the plots. In the first year they showed no improvement from their original state and were grazed by the cattle only in little patches here and there. In the second year there was evidence of some improvement, and a larger area was grazed. In the third year they showed a remarkable improvement. Although the sole of grass was not so good, they were approximating in value to the treated parts of the plots and were grazed almost as well.

As has been noted above, a part of the unharrowed one-third of each plot was treated with fertilisers. The part so treated showed a distinct improvement over the parts to which no fertilisers were applied. They were, however, not nearly so good as the parts which were harrowed before receiving the fertilisers.

During the third year three cattle per plot were grazed and the animals were moved from plot to plot. Up until the end of July the total increase in weight was approximately 17 cwt. for the three cattle. Unfortunately no figures are available for weights at the end of the grazing season.

Summary of Results.—A three years' test has shown that on at least certain kinds of soil old pasture may be rejuvenated by harrowing and the application of fertilisers. The improvement by this simple and cheap method of treatment has been found to be almost as great as if the ground had been cultivated by the rotation of crops and reseeding.

In this 11 acre field the increase in weight in grazing bullocks was 17½ cwt. the first year; in the second and third years, although the exact amount was not calculated, it is safe to

estimate it at 50 per cent. greater than that of the first year. In addition to the grazing for bullocks during the summer the improved pasture afforded good grazing for sheep in the autumn and winter.

The cost of the harrowing of all the experimental areas is estimated at £6. The total cost of the fertilisers used for the whole three year period was £32. Hence, apart from the improvement of the pasture, which will continue for a year or two even without further treatment, there has obviously been an immediate economic return for the outlay.

It is not to be expected that all poor permanent pastures would respond to the same extraordinary extent as these fields. The response would obviously depend upon the nature of the soil. But there is a big acreage of land in this country with soil which is moderately good and on which the deteriorated pastures could be rejuvenated and improved by this relatively cheap method of mere harrowing and fertilising.

This report has been drafted by Dr. J. B. Orr and Mr. A. Crichton of the Rowett Institute, who co-operated with Sir Leybourne Davidson and Mr. Forbes in the carrying out of the experiments.

The Wintering of Cattle.

THE following article has been contributed by Mr. J. A. More, B.Sc., University of Edinburgh, and Mr. A. S. B. Wilson, B.Sc., Edinburgh and East of Scotland College Farm, Boghall.

In April and again in October 1930 there appeared in this Journal accounts of experiments on the wintering of cattle in the north-east of Scotland. These experiments compared the live weight increase of cattle wintered on grassland with that of similar animals housed in byres, all the cattle receiving turnips and straw more or less according to appetite. The results showed that under the conditions of the experiment the out-wintered animals made the better gains at the cost of considerably more turnips, and that they did better than the byre wintered cattle during the subsequent grazing season. On the whole, the implication of the articles was that the out-wintered animals were more profitable because of their better growth during summer.

In view of the evidence from the north of Scotland, it was decided in the autumn of 1930 to investigate the wintering problem at Boghall Experimental Farm, which is situated on the lower slopes of the Pentland Hills a few miles from Edinburgh. Owing to the farm being elevated, exposed and lacking in field shelters it was thought best to compare court-wintered cattle with others running on grassland during the day but having the shelter of a court at night.

The cattle obtained for the experiment were 14 Aberdeen Angus cross-bred calves from St. Boswells and 10 Galloway cross-bred calves from Newcastleton; the average cost of the former

was £13, 10*s*. and of the latter £13, 18*s*. 6*d*. All were suckled calves and their average weight was about 4½ cwt. The animals were divided into two groups for in- and out-wintering respectively, and each group was made up of the same number of Angus and Galloway crosses.

The Daily Rations.—The inside cattle were given 2 lb. of concentrates, 4 lb. hay, as much straw as they liked, and such roots as they could clean up in a reasonable time. The consumption of straw was calculated from the quantities required to keep the racks supplied.

The outside cattle had the run of 24 acres of old pasture. They were given half their concentrates and roots first thing in the morning before being turned out to grass and the remainder on being brought in from pasture at 3 p.m. They consumed their hay and straw at will when in the court. They got the same concentrates and hay as the inside group.

As the winter advanced all the cattle consumed more roots, but at no time did the outside animals consume more than those in confinement. The straw was replaced by hay at the beginning of April owing to the supply of the former being short. In order to get the full effect of the change from house to grass feeding, the inside cattle were neither accustomed slowly to grass nor were they fed concentrates during the first of the grass season. During the grazing season and the subsequent house fattening period all the cattle received the same treatment. The grass stocking was at the rate of a bullock per acre.

The actual changes in the feeding of the cattle were as follows :—

Date.	*Outside Cattle.*	*Inside Cattle.*
1930.		
Nov. 1.	10 lb. swedes. 4 ,, hay. 5 ,, straw. 1 ,, bruised oats. 1 ,, dec. earth nut cake	20 lb. swedes. 4 ,, hay. 6 ,, straw. 1 ,, bruised oats. 1 ,, dec. earth nut cake.
,, 20.	Swedes increased to 15 lb.	Swedes increased to 30 lb.
,, 27.	Straw do. 9 lb.	Straw do. 9 lb.
Dec. 21.	Swedes do. 20 lb	
1931.		
Jan. 5.	Do. do. 27 lb.	
,, 19.	Do. do. 33 lb.	Swedes do. 36 lb.
,, 26.	Do. do. 40 lb.	Do. do. 40 lb.
Feb. 5.	Do. do. 48 lb.	Do. do. 48 lb.
,, 9.	Oats do. 2 lb.	Oats do. 2 lb.
,, 9.	Hay decreased to 3 lb	Hay decreased to 3 lb.
,, 12.	Swedes reduced to 45 lb.	Swedes reduced to 45 lb.
Mar. 25.	Do. do. 40 lb.	
Apl. 1.	Do. do. 25 lb.	
,, 1.	Straw replaced by hay.	Straw replaced by hay.
,, 6.	Kept out at night. Swedes reduced to 18 lb. Concentrates changed to— 2 lb. oats. ¾ lb. cotton cake. ¾ lb. linseed cake.	Concentrates changed to— 2 lb. oats. ¾ lb. cotton cake. ¾ lb. linseed cake.
,, 20.	Swedes and concentrates stopped.	
May 4.		Put to grass and all supplementary food stopped.

Date.	*All Cattle.*
1931.	
July 20.	2 lb. cotton cake. 1 ,, maize.
Aug. 3.	2 lb. cotton cake. 2 ,, maize. 1 ,, dec. earth nut cake.
Sept. 24.	Cattle brought in for winter feeding. Ration.—10 lb. of a mixture of 3 parts oats. 2 parts barley. 2 ,, maize. 2 ,, dec. earth nut cake. Second cut grass according to appetite.
Oct. 15.	Grass replaced by 50 lb yellow turnips. Hay *ad lib.*

Live Weight Increase.—The cattle were weighed every four weeks at the beginning of the experiment and approximately every fortnight after the start of the grass season. The weighings covered the period Nov. 17th, 1930, to Nov. 23rd, 1931.

The average weights of the animals in the different groups at the start of the trial, the date of turning out to grass, the date of bringing in for house feeding and on the 371st day of the trial were as follows :—

	Inside.						Outside.					
	Galloway crosses.			A.A. crosses.			Galloway crosses.			A.A. crosses.		
	cwt.	qr.	lb.	cwt.	qr.	lb.	cwt.	qr.	lb.	cwt.	qr.	lb.
November 17	4	1	15	4	3	10	4	1	17	4	3	1
May 4	6	3	2	7	1	1	5	3	14	6	1	6
September 24	8	1	10	8	3	3	8	3	15	8	3	5
November 23	9	2	14	9	2	25	9	3	26	9	2	19

Graphs showing the changes of weight throughout the winter and grass season are shown on page 72.

Results.—The housed cattle made better gains during winter than did the animals that were kept on grass during the day. These better gains—amounting on the average to almost a cwt. per head—were secured at the cost of only slightly more forage and roots.

On being put to grass the inside cattle lost almost all the gain they had made over the outside animals during winter.

After the initial loss of weight on being put to grass, the house-wintered Aberdeen-Angus crosses continued to grow at practically the same rate as the out-wintered ones. If they did not recover their former lead they showed no evidence of doing worse on the grass because of their winter housing. The Galloway crosses that had been house-wintered did equally as well as the others for some time after settling down to their grazing, but towards the end of the season did drop behind.

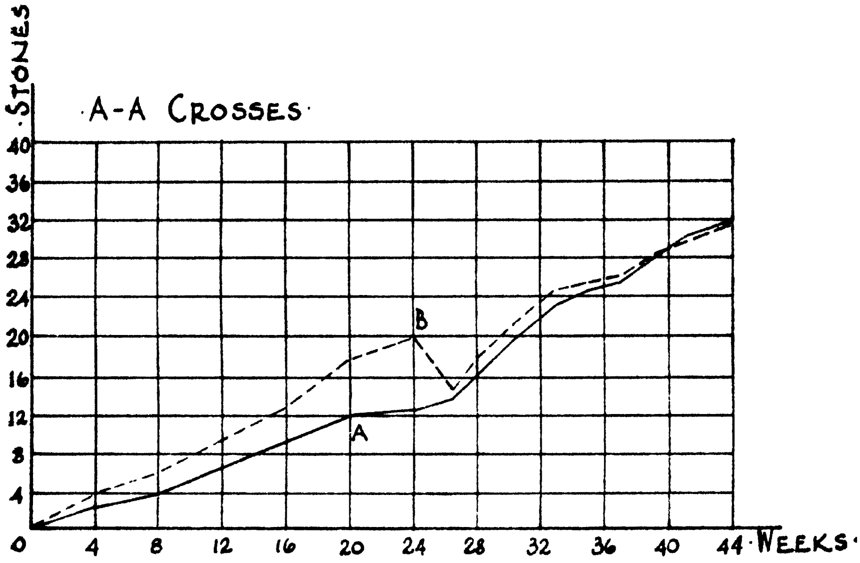
During the final house feeding period there was no significant difference in the gains made by the cattle. Actually the two Angus groups did practically the same, and the in-wintered Galloways recovered some of the disadvantage they had shown as

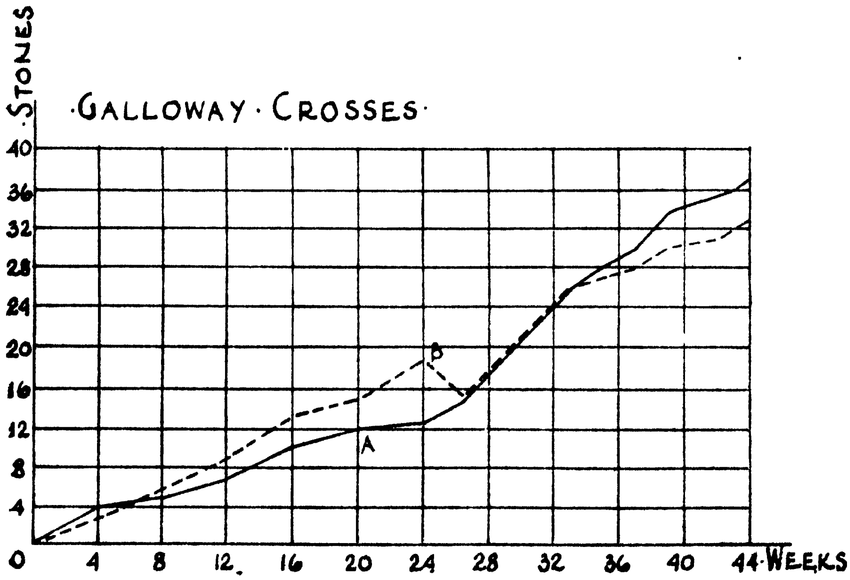
LIVE WEIGHT INCREASE.

Period: Nov. 1930 to Sept. 1931.

Outside Cattle ——— Inside Cattle - - -

A. Kept out at night. B. Put to grass.





compared with the other Galloways towards the end of the grazing season.

During the year of the experiment the Galloway crosses gained on the average half a cwt. more than did the Angus crosses.

Conclusions.—Taken over the full year it appears to matter very little whether young cattle designed for the butcher are wintered in courts or partly in the open.

If good quality suckled calves are wintered under cover and adequately fed they will be so advanced in condition in spring that they cannot be changed over to grass without considerable loss of flesh. If the housed calves in this experiment had been a little more heavily fed during winter they might possibly have been finished off in the courts on cut grass and marketed as baby beeves in June or July.

As previously pointed out, the cattle were turned out to grass in spring in such a way as to place them at the greatest possible disadvantage as compared with the out-wintered animals. The usual practice of accustoming cattle gradually to grass and of feeding astringent concentrates for a few weeks to correct scouring would most probably have enabled the animals to retain more of their winter condition.

Potato Industry in South America.

THE following notes on the potato industry in certain countries in South America are contributed by Mr. W. J. Campbell, Merchiston Place, Edinburgh.

Of the countries I visited the Argentine Republic is by far and away the most important, and my investigations were principally directed towards finding a probable market for Scottish seed potatoes. The potato may have originated in a hot country and is believed to be a native of the elevated districts of several South American countries, but it has been found that a north temperate climate is more conducive to the successful growing of potatoes and experience has shown that Scotland is theoretically and practically the most favourably situated country in the world for the production of seed potatoes.

Priding myself on the superiority of an article with which I am somewhat familiar, it was a matter of considerable chagrin to me to be told that " English " potatoes have proved a failure. In fact the universal opinion expressed to me was that English potatoes are useless for seed purposes in Argentina. Doubtless the seed that created this impression would be " English " and probably deteriorated seed at that, because it is only in recent years that some of the causes of deterioration have been recognised, and it is well known that the potato degenerates in the warmer climate of England. So far as is known to me England grows only one variety of the type required that could be

exported with confidence, the variety that is little affected by the leaf diseases. Argentine growers want a long white potato with a white skin and that is the type that is mainly grown. Not only does that type meet the home demand but it is the type demanded by Brazil, to which the export crop is almost entirely shipped. Brazil will not have a round or a coloured potato. Several of these one-crop countries like Brazil are now encouraging the growing of potatoes, and in fulfilment of that purpose are putting a tariff on eating potatoes. Thus the field for seed potatoes is being enlarged, as these countries must import seed.

Before the war Argentina imported about 30,000 metric tons annually. France was the main source of supply and the variety mainly Early Rose. That variety has, however, fallen into disfavour both on account of poor quality and of failure to crop, and now there may be said to be no imports from France. Naturally a potato is wanted to take the place of Early Rose and here there is an opportunity. The Argentine crop is about $3\frac{1}{2}$ tons per acre, but I could not reconcile that small yield with the large tubers I examined in a store where there were said to be 60,000 bags of potatoes, mostly large sized potatoes like rough Majestic tops. The variety was said to be Burbank, but I found potato knowledge very deficient. The yield per acre has been so unsatisfactory that the railway company (financed by British capital) serving the most important potato district acquired the services of a potato pathologist from Canada to study the question and make proposals. As a result of these investigations some stocks of potatoes have been imported from the certified stocks of Canada. The resulting crops were not very satisfactory, in fact were rather poor, but it must not be forgotten that the experience of the country is that first year's imported seed usually gives a poor result. Thus the main object in importing seed is not to produce a big crop but to produce seed for subsequent crops. The yield from imported seed is approximately $2\frac{1}{2}$ tons per acre, and the attendant loss prevents importation on a large scale.

In the North, Central and Western provinces there are two potato crops yearly, but seed is not obtained from these districts; in fact these districts are not of primary importance from a potato point of view. Seed for the Republic is obtained mainly from a district fully a couple of hundred miles south of Buenos Aires where only one crop is grown in the year. Planting time in that southern district is from the middle of October till the middle of November, and therein lies the almost insurmountable difficulty from the Scottish point of view. Only by previous preparation for an assured market could the business be undertaken satisfactorily, because otherwise our crop normally would not be ripe and ready to deliver in Argentina by October. There is not an assured market. During the growing season heavy rains are not infrequent, as also prolonged droughts, both of which can spoil the crop. In any case the period of growth is

short, from three to three and a half months, and the crop is gathered before the hot weather begins in the summer.

Imported potatoes are more favoured by the public than the home grown and command a better price. A couple of years ago there was a crop shortage and a considerable quantity of potatoes was imported from Europe, about one-fourth of which was from Britain. High prices following the crop failure induced the planting of a larger acreage, which resulted in a glut, and when I was there the price to the grower was under £2 per ton. Consequently there were no importations of seed last season, as the farmers could not afford to buy. The rate of exchange is so heavily against the South American countries that buying by them from this country is almost prohibitive. In the Argentine for our £1 we got the equivalent of 30*s.*, in Uruguay and Brazil 40*s*. These countries are becoming hungry for manufactured commodities and, when they are able to buy, seed potatoes will also be urgently required.

In an article like potatoes, where a defect may not be detectable until it is too late, no exports from this country should be allowed unless certified, and not only certified but from the best stocks. The honour and good name of the country should be put before private profit.

As far as I could gather, Canada is the country that is putting herself in the best position to supply South America with seed potatoes. She is north of the equator just as we are, and latitudinally is in no better position. But she is before us in the certification of seed potatoes both for purity and health, and is therefore in a better position to boost her wares. I found our great Dominion doing that work when I was there in 1923. We are not yet certifying for health although we have the best stocks in the world, nor is the fullest advantage being taken of these good stocks at home. The Canadian Federal Department of Agriculture is co-operating with the Department of Trade and Commerce to find new markets for their certified seed potatoes and with that object are making trial shipments, which appear to be a necessity in opening new foreign markets.

THE following notes on the cost of growing oats in the north-east of Scotland have been supplied by Dr. A. D. Imper, Agricultural Economist at the North of Scotland College of Agriculture.

During the past year many enquiries as to the cost of production of oats have been received and it is thought that an average figure would be of value.

Cost of growing Oats in the North-East of Scotland.

The undermentioned figure is obtained from farms on which full cost records are kept. The actual accounting and apportionment was done in the office of the College Economist.

It is difficult to consider one crop or one enterprise apart from

the farm as a whole, but under present circumstances it may be justifiable to look into the cost of the individual units which enter into the farm structure. Climatic conditions cause variations from year to year and it is scarcely possible to give a figure which would not be subject to criticism from some angle. Costs, as the word infers, refer to financial outlays, and from year to year these outlays will vary for the same articles purchased, so that in order to keep the figures comparable over a period, quantitative data are also presented.

The figures are compiled from records kept during the crop years 1928-29, 1929-30 and 1930-1931, and refer to the preparation of the land, sowing, manuring and harvesting of the crop along with the actual direct outlay on seed and manures. The general overhead charges of the farm have been apportioned on the usual cost accounting bases and credits allowed are calculated from the recognised tables.

It has been possible to differentiate between oats grown after turnips and oats grown after lea.

Labour requirement and cost of producing 1 acre of Oats.

Operation.	Clean land. Man hrs.	Clean land. Horse hrs.	Clean land. Cost.	After lea. Man hrs.	After lea. Horse hrs.	After lea. Cost.
Ploughing	10 1	20·2	£1 1 2	12·5	25·3	£1 6 8
Preparing seed-bed, sowing oats and manure, &c. ...	3·9	5·2	0 6 9	4·4	7·9	0 9 1
Cutting, stooking, leading and stacking	19·4	8·9	0 19 2	22·3	10·8	1 4 10
Man and horse labour cost			£2 7 1			£3 0 7
Seed			1 0 11			1 0 0
Manure			1 1 1			0 8 2
Dung and manure residues and cleaning ...			1 8 4			—
General overhead charges			1 1 5			1 6 11
Rent and rates			1 4 9			1 4 9
Total Expenditure			£8 3 7			£7 0 5
Deduct manurial residue ...			0 8 9			—
Cost per acre			£7 14 10			£7 0 5

Comparing the figures, it is noticeable that the labour requirements on lea oats are greater than on clean land. This is as would be expected. The figure for cutting, &c. shows the greatest variation. This is affected by the condition of the crop, by rain during the operations and by distance to cornyard. A study of the labour records shows that the weather (causing " setting up " and " shifting stooks ") has the greatest effect.

Although the labour cost on clean land is less than after lea the total cost per acre is greater. It is noticeable that the majority of farms for which records are received do not manure the lea crop but give the clean land crop a good dressing. This

causes the average cost to be greater, especially when this crop must bear a proportion of the cleaning, dung and artificial manure residues.

The general overhead charges include the apportionment of upkeep, replacement and depreciation of tenant's fixtures and implements and any outlays for overhead expenses, in short what are known in cost accounting as establishment and repair and renewal charges.

It has not been considered desirable to go into the cost of threshing, as the practice of the district is varied. Some farmers thresh the crop by portable steam mill—this usually entailing the employment of extra men (sometimes lent by neighbours)—while others thresh the crop by their own mill either in large or small quantities as granary and straw shed accommodation permit. These variations in practice cause an average figure to have little significance.

The result is given as a cost per acre, and it is believed that this figure will be fairly representative of the cost on the medium loam of the north-east irrespective of the yield of the crop. The position may be stated thus :—The labour requirement on ploughing, preparing the land, and sowing per acre will be practically constant for any medium loam; the cutting and stooking will vary very little, but the leading and stacking will be influenced by the bulk. The average crop grown on the farms was estimated (on one only was it bagged and weighed) at 7 qrs. The charges for manure and rent of course vary from farm to farm, but it is thought that the figure given is fairly representative of the district. It must be understood that the figure termed rent in the table is :—rent, rates and proportion of the fire insurance paid to the landlord by the tenant.

The labour requirement applied directly to the crop is 33·4 man hours and 34·3 horse hours per acre on clean land, 39·2 man hours and 44·0 horse hours on lea land, but to this figure 5·5 and 6·3 man hours respectively must be added for establishment duties, making a total of 38·9 and 45·5 man hours the total labour paid for by one acre of clean land and lea oats respectively.

The Control of the Annual Nettle.

THE following report on experiments conducted by the Edinburgh and East of Scotland College of Agriculture on the control of the annual nettle amongst catch crops sown after early potatoes has been contributed by Mr. T. Young, M.B.E., N.D.A., and Mr. R. G. Heddle, M.A., B.Sc., who were responsible for the conduct of the experiments.

Farmers who grow considerable acreages of early potatoes frequently experience trouble with the annual nettle. This

weed, like its close relative the common stinging nettle, is a lover of heavily manured land, and the heavy dressings of nitrogenous manures applied season after season to the early potato land are no doubt responsible for the prevalence of the weed. In the potato crops themselves the weed is not particularly troublesome, as it can be readily destroyed by the ordinary operations of cultivation, but in the catch-crop, usually rape, rye, barley or Italian rye-grass, which is sown after the potatoes are lifted, it often becomes a serious pest.

An experiment was carried out this season at the farm of Mr. Robert Miller, Ferrygate, Dirleton, under the auspices of the Edinburgh and East of Scotland College of Agriculture, to test the effect of certain chemical sprays in destroying the nettle. Mr. Miller's previous experience had been that spraying with copper sulphate at the rate of 30 lb. per acre was not effective in killing the weed. The catch-crop was Italian rye-grass sown in the middle of July at the rate of two bushels per acre.

Three chemicals were used in the tests, which were carried out on small plots, namely—copper sulphate at the rate of 30-40-50 lb. in 50 gallons of water per acre, iron sulphate at the rate of 100-200 lb. in 60-70 gallons of water per acre, and sodium chlorate at the rate of 2½ lb. and 5 lb. in 50 gallons of water per acre. The iron sulphate was found to be quite ineffective, while copper sulphate had to be used at the very high rate of 50 lb. per acre in order to produce much effect. Sodium chlorate, however, proved remarkably effective in destroying the nettles. On one plot, which was sprayed at the rate of 5 lb. of sodium chlorate in 50 gallons of water per acre, the nettles were almost completely destroyed, while on another plot sprayed at half this rate a very considerable reduction was effected, the result on the latter plot being at least as good as that secured where 50 lb. of copper sulphate per acre were used. The Italian rye-grass, where the sodium chlorate spray was used, was considerably scorched at the tips of the leaves, but the plants quickly recovered, and by the time the sheep were turned on to the grass no sign of damage to the crop was visible. The sprayed plots were grazed quite satisfactorily and there was no reappearance of nettles.

It is intended to conduct further experiments in future in order to test the effect of the spray on other weeds and other crops, as well as to determine the minimum effective rate of application. Sodium chlorate can be purchased at present at about 30*s.* per cwt., so that the cost of materials, if the spray is applied at the rate of 5 lb., works out at about 1*s.* 3*d.* per acre, a price which compares very favourably with that of the chemicals usually employed for weed spraying at present.

Another trial, with a view to combating the nettle, was conducted on the same farm and in this case marrow stemmed kale was the catch-crop. In preparing the land a single plough was used to make drills about 25 inches apart, the potato "shaws" being disposed of in the bottom of the drill just made. The

kale was then sown in the drills at the rate of 2½ lb. per acre and was left unthinned. The main object in sowing in rows was to allow of destroying the weeds by means of the disc horse hoe, and this implement was used with good effect as soon as the nettles made a start to grow. In this way the nettles were kept very much in subjection, and by the middle of October the kale was a satisfactory crop. It should be remembered, however, that kale is subject to finger-and-toe, and the trial indicated that 3 lb. per acre of seed might give more satisfactory results than 2½ lb. It is hoped to continue this experiment also in another year.

The results of the experiments are highly encouraging, and while too much reliance should not be placed on a single trial, there are good reasons for believing that the early potato grower has within his reach a successful and inexpensive method of destroying a bad enemy.

Craibstone.

Notes from Agricultural Colleges

Potatoes, 1931.—In the case of the potato, as with all farm crops, the date of planting has a very great influence on the ultimate yield and quality of the crop, but the condition of the soil at the time of planting is also of first importance and, therefore, no hard and fast rule can be laid down as to the best time.

During the last few years a trial has been made where potatoes are planted at the beginning and middle of each month. A snowstorm at the beginning of March delayed the first planting this year until the middle of that month, and even at that time the soil was not in good order. The following results were obtained with Arran Banner and Golden Wonder, half of each variety at each planting being sprouted and the other half unsprouted :—

Arran Banner.

	Sprouted.										Unsprouted.									
	Over 2 ins.		Between 2 ins. and 1¼ ins.		Small.		Diseased.		Total.		Over 2 ins.		Between 2 ins. and 1¼ ins.		Small.		Diseased.		Total.	
	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C
March 16th	11	1	3	13	0	15	0	17	16	6	9	9	3	12	0	13	1	14	15	8
April 1st	9	19	5	15	0	13	1	3	17	10	8	8	4	17	1	3	1	3	14	15
,, 16th	9	9	5	8	0	16	0	17	16	10	8	5	5	0	1	7	1	2	15	14
May 1st	8	19	6	0	0	17	0	15	16	11	5	15	6	1	0	18	0	18	13	12
,, 16th	8	3	6	3	0	15	1	6	15	7	5	7	6	13	1	2	0	16	13	18
June 1st	9	19	4	9	1	1	0	12	16	1	4	14	5	1	1	3	1	3	12	1
,, 16th	7	7	3	18	0	13	0	12	12	10	3	16	5	15	1	9	0	7	11	7

Golden Wonder.

	Sprouted.								Unsprouted.							
	Over 2 ins.		Between 2 ins. and 1¼ ins.		Small.		Total.		Over 2 ins.		Between 2 ins. and 1¼ ins.		Small.		Total.	
	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.
March 16th ...	6	1	4	1	0	12	10	14	3	3	4	16	0	17	8	16
April 1st ...	6	9	4	1	0	8	10	18	3	8	4	6	1	1	8	15
,, 16th ...	6	3	5	7	1	1	12	11	3	3	4	12	1	1	8	16
May 1st ...	9	11	4	12	0	14	14	17	3	11	4	16	0	17	9	4
,, 16th ...	8	13	4	10	0	17	14	0	2	17	5	5	1	9	9	11
June 1st ...	2	17	4	14	1	3	8	16	1	10	3	8	1	1	5	19
,, 16th ...	2	7	4	9	1	1	7	17	0	9	1	12	1	9	3	10

In the case of Arran Banner there was not much difference in the total yield from the sprouted seed of the different plantings except in the last planting, which was distinctly less, whereas with the unsprouted tubers the May plantings were also less than those planted earlier. Generally, there were more large tubers in the early plantings than in the later and a gradual increase in the quantity of tubers of seed size up to the middle of May, after which they decreased.

With both the sprouted and unsprouted Golden Wonder the May plantings produced the heaviest yields. Undoubtedly the reason for this was the low temperature of the soil at the earlier plantings, as it was almost into May before it reached 40°F., whereas in many other seasons this temperature was reached much earlier. Also Golden Wonder grows very slowly at first.

Blight reduced the yield of both varieties, but more severely in the case of the Arran Banner, the shaws of which were destroyed earlier, which is a likely reason for the crops from the unsprouted May plantings being comparatively less than in the case of Golden Wonder.

The value of planting well sprouted seed was again well demonstrated, as there was an average increase of 2 tons with Arran Banner and 3 tons 11 cwt. with Golden Wonder; it may be again stated that when sprouted the quality is distinctly improved, as the tubers are nearer maturity when lifted.

Blight appeared much earlier than is usually the case, the first spot being seen about the beginning of August. It began to spread slowly, but harder weather which set in about a week later checked it. In less than another week, however, foggy weather was experienced and the disease spread further and most of the early varieties were affected. About the 20th it appeared to be checked again, but at the end of the month fog during the night and sunshine during the day caused it to spread rapidly among the second earlies and maincrops.

Although the shaws, except in the case of a few late varieties, were destroyed, fine sunny weather in September and the fact of the soil being comparatively dry prevented the tubers from being badly affected.

The following list shows the percentage (by weight) of tubers affected among early varieties :—

Duke of York	32	Sharpe's Express ...	11
Di Vernon	4	Witchhill	33
Ninetyfold	60	Early Pink Champion	½
Early Eclipse	19	Entente Cordiale ...	22
Epicure	14	Immune Ashleaf ...	10
Arran Crest	12	Mein's Early Round	14
Arran Rose	27	Edzell Blue	11
Arran Pilot	18	Katie Glover	13
May Queen	17	Dargill Early	9
Puritan	19	Catriona	11

While these figures are in some cases somewhat different from those of last year and in other years, in other cases they are in agreement. For example, Duke of York, Ninetyfold, Arran Rose and Witchhill have been always badly affected, while Di Vernon, and especially Early Pink Champion, have been always comparatively free from blight.

The following are the percentages obtained in the second earlies and maincrops :—

Queen Mary and Arran Victory	0
Ally	½
Field Marshal	1
Kerr's Pink, Herald and Golden Wonder	2
Northern Star, Majestic, Arran Consul and Irish Chieftain	3
Arran Banner, Arran Chief and Up-to-date ...	4
King Edward and Langworthy	5
British Queen, Sefton Wonder and Abundance ...	6
Great Scot	10
Arran Comrade	20
Champion	30

It will be noted that the three varieties—Sefton Wonder, Field Marshal and Golden Wonder—with russet skin, were less affected by blight than their corresponding varieties—Great Scot, Up-to-date and Langworthy—with plain skin.

Golden Wonder was used in a trial with different size of setts and the following results were obtained. In all cases the tubers were planted 12 in. apart in 27 in. drills. Half of the seed of each size was sprouted and the other half unsprouted.

[TABLE.

Golden Wonder—Size of Setts.

	Ware.		Seed.		Small.		Total.		Less Seed.		Nett Crop.	
	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.
SPROUTED.												
6 oz... ...	6	17	5	15	1	7	13	19	3	0	10	19
4 ,, ...	7	12	5	1	1	2	13	15	2	0	11	15
2 ,, ...	7	17	4	7	0	12	12	16	1	0	11	16
1 ,, ...	6	13	2	12	0	12	9	17	0	10	9	7
½ ,, ...	6	11	1	12	0	9	8	12	0	5	8	7
UNSPROUTED.												
6 oz.... ...	3	6	5	6	2	4	10	16	3	0	7	16
4 ,, ...	3	15	6	3	2	2	12	0	2	0	10	0
2 ,, ...	3	13	6	0	1	0	10	13	1	0	9	13
1 ,, ...	3	18	4	11	0	14	9	3	0	10	8	13
½ ,, ...	4	7	2	7	0	5	6	19	0	5	6	14

These results agree in the main with those of previous trials, and the following points will be noticed :—

1. Large seed generally produced a heavier total crop than small seed.
2. The increased crop, however, was not always sufficient to make up for the extra seed.
3. For the production of ware there was little difference between 2 oz. and 4 oz. setts.
4. The larger setts, however, produced the largest amount and proportion of seed size.

In a season like this, when there is apparently to be a scarcity of seed size tubers to plant, the question naturally arises, " Why not cut more so as to make the available supply go round? " The experience of many growers, however, is that a poorer crop results, and they are loath to use cut seed. This poorer crop, however, is undoubtedly due in many cases to the fact that the proper method had not been followed.

Many trials with cut seed have been carried out, and the following conclusions have been drawn :—

1. A cut sett will produce approximately the same crop with the same proportion of ware as a whole sett of the same size. In a trial where whole and cut seed have been used for the past fourteen years, that is using cut seed from cut and whole seed from whole every year, the following average results have been obtained with three varieties.

	Per acre.			
	Whole.		Cut.	
	tons	cwt.	tons	cwt.
Abundance	14	7	14	11
British Queen	15	7	14	17
Great Scot	16	1	16	1

2. The cutting should be done out of the sun and the cut surface allowed to heal slowly, or a sprinkling of lime should be made on the cut surface.

In a trial carried out with Majestic for seven years the following average results were obtained :—

	tons	cwt.
Cut in shade and allowed to dry slowly for several days	14	8
Cut in sun and planted	11	7
Cut in sun, limed and planted	13	14

3. If some of the tubers are the produce of plants affected with virus diseases (leaf roll, mosaic, &c.) cutting will tend to spread these diseases. Hence it will be well not to keep any of the produce for seed. On the other hand, if there are no virus diseases present, cutting may safely be done, as was shown in the above trial with Abundance, British Queen and Great Scot.

As Golden Wonder is usually considered to be a poor cropper, a trial has been carried out for several seasons in order to demonstrate that, if precautions are taken to ensure that the conditions are suitable, quite a decent crop may be obtained.

In one plot the conditions were made as suitable as possible; the seed, which had been selected from healthy plants (free from mosaic), was well sprouted, and the manuring (along with dung) was a mixture that had generally proved to be the most economical here, viz. 1½ cwt. sulphate of ammonia, 3½ cwt. superphosphate and 1 cwt. sulphate of potash.

In the other plot ordinary unselected seed which had not been previously sprouted was used and the manuring was comparatively poor, viz. ½ cwt. sulphate of ammonia, 1½ cwt. superphosphate and ½ cwt. sulphate of potash.

The results were as follows :—

Good Conditions. Selected seed. Well sprouted. Well manured.								Poor Conditions. Ordinary seed. Unsprouted. Ordinary manuring.							
Ware.		Seed.		Small.		Total.		Ware.		Seed.		Small.		Total.	
T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.
8	9	4	6	1	8	14	3	1	8	3	8	1	5	6	1

Golden Wonder was also used in a trial where concentrated artificial manure was compared in triplicate with a mixture made up to contain the same amounts of nitrogen, phosphoric acid and potash. The quantities required were—1½ cwt. sulphate of ammonia, 1½ cwt. superphosphate and 1⅝ cwt. sulphate of

potash. The same amount of dung was used in each case. The results were as follows :—

	Concentrated Manure.								Mixture.							
	Ware.		Seed.		Small.		Total.		Ware.		Seed.		Small.		Total.	
	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.
A.	4	13	5	9	0	12	10	14	4	7	4	17	0	9	9	17
B.	4	14	5	6	0	12	10	12	4	14	5	2	0	12	10	7
C.	3	18	5	16	0	13	10	7	4	3	5	4	0	11	9	18
	Average						10	11	Average						10	1

The results indicate that while there is not a great difference between them, the concentrated had a slight advantage over the mixed manure. It should be kept in mind, however, that the former contains rather less phosphates than our trials indicate to be necessary for our conditions.

Reviews.

The Journal of the Orkney Agricultural Discussion Society, 1931.—Evidence of sustained interest and healthy activity on the part of the members of the Orkney Agricultural Discussion Society is abundantly provided in this volume—the sixth of the series. Like its predecessors it has been capably edited by the secretary, Mr. H. H. Corner, to whose energy and enthusiasm much of the success of the Society is due.

A marked feature of the contributions is their eminently practical character. As is pointed out by two of the contributors, cattle rearing and feeding is the mainstay of the Orkney farmer, and it is fitting therefore that several of the papers devote special attention to that branch of the industry. Mr. R. Hourston gives a full description of " Experiments in Cattle Feeding " carried out at Quoyberstane in 1929-30, in conjunction with the College of Agriculture representative. Trials were made with linseed *versus* oatmeal; winter feeding of yearlings; yearlings at grass; wintering of two-year-old cattle; and with home-grown linseed. In connection with the last-named experiment, it is noted that yields as high as 10 cwt. per acre were obtained, and it is suggested that with experience it may be found possible to grow linseed in the islands in such quantity as to make them independent of foreign supplies.

Another useful paper by Mr. J. G. S. Flett records the changes that have taken place in the " Seeding of Grasses and Clovers." He gives credit to the staff of the North of Scotland College of Agriculture for the sound practical advice they have given in this connection, resulting in all-round improvement—bigger and better quality grain crops, larger and healthier turnip crops, heavier and better hay, better pastures, and greater stock-

carrying capacity of the farms. In proof he quotes these figures of cattle and sheep in the Islands in 1925 and 1930 :—

	1925.	*1930.*
Cattle	30,441	36,081
Sheep	34,892	63,869

A similar cheerful spirit characterises a paper on "Agricultural Progress in Orkney" by Mr. John Mooney, who calls attention to other factors that have helped forward agricultural improvement in the last seventy years. Of one of these—the division of the commons—he gives a most interesting historical account. The hills, moors and waste lands of Orkney had been commons from early times, and it was not until the middle of the nineteenth century that they were allocated to individual proprietors by legal process, with the result that they immediately began to be improved pastorally. Mr. Mooney likewise gives credit to the enterprise of Kirkwall merchants for the introduction of artificial manures, better seeds and wild white clover. He wisely pays tribute also to the representatives of the College of Agriculture, but he claims credit too for the progressive spirit of the Orkney farmer and the influence of the Discussion Society.

"Buttermaking and Cheesemaking on the Farm" is the subject of an instructive article by Miss M. A. Leslie, who gives full directions for the production of butter and cheese of good quality.

Mr. W. J. Moar contributes a well-authenticated account of the "Climate and Weather of Orkney and its bearing on Agriculture," with references to outstanding seasons in early records and in more recent years. Other practical matters dealt with include "Farm Buildings"; "Farmyard Manure"; "Grub in Oats"; "Transplanting Turnips for Seed"; "Management of Farm Stock"; Rearing and Marketing of Cattle"; and "An Eight Course Rotation."

The Society held debates—here duly reported—upon "Horse *v.* Mechanical Traction" and "Free Trade and Protection." They carried through a Stack Building competition and they held an examination in Rural Science for the pupils attending the County classes in agricultural subjects.

Altogether the activities of the Society deserve the heartiest commendation, and this record of them reflects much credit on the membership.

Copies of the Journal may be had from the Secretary, Agricultural College Office, Kirkwall, post free 1*s.* 3*d.*

Baillière's Encyclopædia of Scientific Agriculture. Edited by H. Hunter, D.Sc. Two Vols. London: Baillière, Tindall and Cox. Price 63*s.*—Having in mind the number of encyclopædias and other general publications dealing with agriculture in all its aspects one is inclined to ask whether there is room for another such publication at present. The editor and publishers, however, claim for this Encyclopædia that it has a special out-

look and purpose. It is intended, they say, to present the various branches of agriculture in the new aspect they are gradually assuming under the influence of scientific inquiry; and they rightly point out that since the war scientific inquiry into the problems of agriculture has been carefully systematized, and that numerous agencies have been in operation investigating these problems and have already produced results which are capable of influencing practice so as to fit it better to modern conditions.

Planned accordingly to present the results of scientific investigation, the Encyclopædia assumes on the part of the reader a knowledge of the ordinary operations and equipment of husbandry. There is, for example, no account of live stock as such, although farm animals receive much attention in the articles dealing with breeding, nutrition and disease. Similarly, since agricultural machinery already has an extensive and up-to-date literature, no attempt is made here to treat it comprehensively, although certain special applications are included.

A particular feature is made of surveys of the agriculture of the various component States of the Empire, and a forecast of the developments considered possible and likely to be made in each case. The survey includes an account of the scientific work carried out in the various countries, and in this connection it is regrettable that more space was not devoted to the organisation for research in Scotland. No reference whatever is made to the Institute of Animal Genetics, the Institute for Research in Animal Diseases, the Hannah Institute for Dairy Research, or the Macaulay Institute for Soil Research, all of which have already accomplished useful work in their respective spheres.

In view of the general plan of the work those who are acquainted with the trend of scientific investigations in recent years will know what subjects they may expect to find dealt with, and they will be gratified to discover that these are all handled by recognised authorities, and that the editor, exercising a wise discretion, has allotted space proportionate to the importance of the subject and to the degree of advance made in its scientific treatment. Thus since soil investigation has been active in these later years its various aspects are fully dealt with, particularly physical and chemical composition, nitrification, colloids and humus, liming, drainage loss, and so forth. In connection with arable and pasture crops the attempts at producing better varieties, at discovering the optimum manurial treatment, at control of diseases and pests are all fully described. The highly important subject of grass management and improvement receives adequate attention and emphasis is laid on the complexity of the problem of breeding forage plants and grasses. Fruit growing, market-gardening and glasshouse cultivation are recognised as rapidly increasing in importance and the results of scientific work in these lines are fully set forth. The preservation of fruits and vegetables and the storage of these and other agricultural products at low temperatures are given due notice. Recent advances in animal nutrition and the

scientific principles of the proper utilization of available food-stuffs are described and methods of determining feeding values are explained in detail. The commercial side of agriculture is not neglected and informative articles appear on farm management and the disposal of farm produce, while useful summaries are provided of legal enactments relating to farm practice. Among miscellaneous subjects may be noted meteorology in its relation to crops, plant diseases and insect pests; definitions of chemical and technical terms; winter hardiness and drought resistance in plants; and the technique of plot experimentation.

The list of contributors contains the names of many outstanding workers in the field of agricultural science, and their contributions may be regarded as authoritative reviews of the present state of knowledge in their respective subjects.

While the Encyclopædia will appeal mainly to the student and the research worker, it contains much information and guidance for the practical farmer.

Nutrition Abstracts and Reviews.—The Imperial Bureau of Animal Nutrition, The Reid Library, Rowett Institute, Vol. I, Nos. 1 *and* 2.—According to the editorial note the purpose of this Journal is to collect under one cover abstracts of all literature bearing on nutrition. Research in animal nutrition has in recent years become so extensive that it is impossible for the individual worker to keep in touch with all its ramifications. He may confine his reading to the particular aspect of the subject in which he himself is interested, nevertheless advances in other lines may at any time have a bearing on his problem. And again the practitioner either in human or veterinary science or in stock-farming has difficulty in getting information about advances in research that might be usefully applied in practice.

The publication accordingly is intended to meet the needs both of the research worker and of the practitioner. Some 450 periodicals are being reviewed by the editorial staff and their assistants, and by correspondents abroad. The abstracts of published papers are to be of sufficient length to indicate the nature of the work and the conclusions drawn from it. The present issue is a double number and deals with literature published between January and October of the current year, and future issues are to appear quarterly.

While the abstracts of papers are to be the main feature, there will also be included reviews of a more general nature setting forth the present state of knowledge of different aspects of nutrition and giving a bibliography of the subject or stating a particular point of view.

The committee of management and the editors are to be heartily congratulated on this first issue. Both literally and metaphorically it is a weighty production. The body of authority indicated in the list of editors and corresponding editors is impressive in number, standing and distribution, and the committee of management contains representatives of the Council

of the Imperial Bureaux, the Medical Research Council and the Reid Library. The acting editors are Dr. J. B. Orr of the Rowett Institute, Professor J. J. R. Macleod of the University of Aberdeen, and Miss Harriette Chick of the Lister Institute, London.

The opening article by Sir Frederick Gowland Hopkins, President of the Royal Society, deals with "Nutrition and Human Welfare." It stresses the importance of quality in food and the proper balance of constituents both organic and inorganic. Professor E. P. Cathcart, F.R.S., describes "Some of the Difficulties in the Quantitative Assessment of Human Diets," and recounts experiences in collecting dietetic data from family budgets. An article by Dr. J. B. Orr on the "Qualitative Aspects of Nutrition" treats of the subject mainly from the point of view of the stock-feeder. He calls attention to the losses incurred from malnutrition both through actual disease and through loss of efficiency in production, and emphasises the necessity for obtaining a properly balanced ration.

It is impossible to mention here any of the 1,334 abstracts of papers which make up the bulk of the volume. Most of them are highly technical in nature, but are obviously of the first importance to the worker in nutrition. They are grouped under the following headings:—Technique, Composition of Foodstuffs, Physiology of Nutrition, Dietetics, Feeding of Animals, Diet in Relation to Health and Disease, and Book Reviews.

The format of the volume is attractive. It is produced by the Aberdeen University Press, and the price is 13*s*., the annual subscription being a guinea.

Bulletins of the Ministry of Agriculture and Fisheries. H.M. Stationery Office, 120 George Street, Edinburgh.

Bulletin No. 28. *Artificial Fertilisers.* (3*s*.)—The first of these bulletins is an important monograph, extending to 200 pages, by Sir John Russell, the Director of the Rothamsted Experimental Station, on the history, composition and use of artificial fertilisers.

Experimental work at Rothamsted on the use of artificial fertilisers was commenced nearly ninety years ago, and the results of this long series of experiments are fully described. It is realised, however, that the results obtained at one experimental station do not necessarily apply to all parts even of a small country like this, and adequate reference is made to the work of other stations, both in this country and the Continent.

The bulletin begins with an interesting account of the discovery of artificial fertilisers and of the early experiments on their use. The nitrogenous, phosphatic and potash fertilisers are then dealt with in detail, a separate chapter being devoted to each. The fertilisers available in each group are described, and their specific effect on the growth, composition and yield of the various crops are fully studied. The effect of differences in soil as affecting the manurial treatment are also considered.

The long continued series of experiments carried out at Rothamsted by Sir John Russell and his predecessors yield a wealth of material for a study of this kind, and the more important results are lucidly described, the text being illustrated with many carefully devised tables.

The later chapters contain a complete description of the manuring of farm crops and the use of compound or mixed fertilisers; there is a useful bibliography and index.

The question naturally arises as to whom this bulletin is addressed. It is certainly too advanced a work for the average farmer, but will be a most useful guide and a mine of information to the county agricultural lecturers and the staffs of agricultural colleges.

Bulletin No. 31. *Studies concerning the Handling of Milk.* (2*s.*)—This is the fourth edition of a research monograph by the Staff of the National Institute for Research in Dairying, University of Reading, which was originally published in 1924. The present edition has been revised and largely re-written. The first chapter is devoted to the essentials of clean milk production; the necessity for an ample supply of pure water is pointed out, and the best methods of washing and sterilising the dairy utensils are clearly explained. The precautions necessary when milking machines are used are described in detail, and tables showing the effect on the bacterial content of the milk of various methods of cleaning and sterilising are given. An important chapter follows on the methods adopted to encourage the production of clean milk. The various Acts regulating the production and supply of milk are referred to and the rather complicated method of " grading " now in use is explained.

Subsequent sections deal with the influence of the bacteriological content of milk upon its keeping quality, faults in milk and milk products, and the properties of raw and heated milk.

This monograph should be carefully studied not only by the actual producers of milk, but by medical officers of health, public authorities and all interested in the provision of an adequate supply of clean milk and in its increased consumption. The fact that a fourth edition has been called for in a short space of seven years is gratifying evidence that this important subject is claiming an increased share of public attention.

Bulletin No. 32. *Pig-keeping.* (1*s.* 6*d.*)—This is a new edition of an important monograph, which was first published in 1925; it is written by Mr. W. A. Stewart, M.A., B.Sc., the Principal of the Moulton Farm Institute, Northampton. The whole subject of the breeding and feeding of pigs is treated from a thoroughly practical standpoint, and the breeds and methods most suitable for this country, as well as the distinctive features of pig-farming in Scandinavia, are described.

The general introduction discusses the question of the farmer's aim, capital and methods of general management.

The next section comprises breeds and breeding and is illus-

trated with photographs of typical animals. The following section gives a clear account of the best methods of feeding, notes on feeding stuffs and rations for different classes of pigs.

The construction of pigsties is fully described, and a set of plans is reproduced illustrating the various types of houses which are recommended.

This is a most useful publication and can be strongly recommended to all who are interested in increasing the pig population in this country.

Bulletin No. 35. The use of Lime in Agriculture. (6d.) This bulletin, which has been revised by Mr. H. V. Garner of the Rothamsted Experimental Station, deals in a comprehensive manner with the use of lime in agriculture.

The functions which lime fulfils in the soil, the causes and rate of loss of lime from the soil, and the indications of the need for lime in a soil are clearly explained. The comparative values of different forms of lime are discussed, and a careful study of this bulletin should do much to clear up the confusion which is so common as to the different chemical substances which are all loosely referred to as " lime." Subsequent sections have reference to the application of lime, the quantities to apply, and the probable duration of its effects. This is a most useful bulletin for farmers.

Bulletin No. 37. Ensilage. (1*s.*)—This bulletin was originally published in 1926 by Mr. Arthur Amos, M.A., late of the School of Agriculture at Cambridge, and Dr. H. E. Woodman of the Animal Nutrition Research Institute at Cambridge. In this second edition, the earlier work has been thoroughly revised and brought up to date. After a brief history of the early attempts at silage-making, an account is given of the different types of silage and the methods by which the type and quality are controlled. The subsequent sections deal with suitable crops, tower silos, clamp silage and stack silage. It is shown that it is possible to differentiate no less than five distinct types of silage :—(1) " Sweet " dark-brown silage; (2) " Acid " light-brown or yellow-brown silage; (3) " Greenfruity " silage; (4) " Sour " silage of various forms, and (5) " Musty " silage. The conditions which produce these different types have been worked out and are shown to depend on such factors as the nature and ripeness of the crop, the temperature in the silo, the amount of water in the crop and closeness of packing.

An important chapter follows on the chemistry of silage; the changes which take place in a crop during ensilage are explained, and the share taken in these changes by direct chemical action as well as the part played by plant enzymes and by bacteria and fungi are discussed. The feeding value of silage, the losses of nutrient constituents in the silo and the feeding of silage form the subject-matter of other sections. The bulletin is written in a clear and attractive style.

Wool Quality. S. G. Barker, Ph.D., D.I.C., &c., &c., Director of Research, Wool Industries Research Association. Published by H.M. Stationery Office. Price £1, 1*s*.—This is a book mainly for the wool technologist, but it contains much that is of interest to the agriculturist. Dr. S. G. Barker, the Director of Research to the Wool Industries Research Association, is a recognised authority on wool, and in this comprehensive treatise he has collected information dealing with all aspects of his subject.

Wool is a natural product, and from its origin possesses qualities which make it pre-eminently suitable for use as wearing apparel. One of its main characteristics, however, is variability, and it is necessary, in order to meet the competition of scientifically produced filaments for textile purposes, that the fullest information possible should be obtained as to the conditions favourable to the development, standardisation and utilisation of those qualities in wool which are desirable from the manufacturing standpoint. Research with this object in view, of which Dr. Barker's book treats, may be expected to be of advantage not only to the manufacturer but also to the producer; but in the case of the latter regard must also be had to other factors, such as the suitability of the fleece for the living sheep and the relative economic importance of mutton and wool. Any steps in the direction of improvement of yield and quality must take cognisance of these factors.

Dr. Barker's book is well printed and contains a large number of illustrations, tables and graphs, together with a full bibliography.

Labour on Scottish Farms.

THE Agricultural Returns collected on 4th June 1931 give the following numbers of workers employed on that date on holdings exceeding one acre in extent. The occupiers of holdings, their wives and domestic servants are excluded, but members of the occupiers' families other than their wives are included.

	Regular workers.	*Casual workers.*
Males, 21 years old and over ...	59,226	5,355
Do. under 21 years old ...	20,144	2,848
Total of males	79,370	8,203
Women and girls	18,060	6,833
Total	97,430	15,036
Grand Total ...	112,466	

The grand total is 3,042 below that recorded in 1930, regular

workers being fewer by 1,867 and casual workers by 1,175. Of the regular workers, men over 21 have decreased by 811 or 1·4 per cent., and males under 21 by 534 or 2·6 per cent. Women and girls regularly employed have decreased by 522, male casual workers by 792, and female casual workers by 383.

The decrease in the number of regular workers since 1921 amounts to 6,441 or 6·2 per cent. Men over 21 are more numerous by 414, while those under 21 have diminished by 3,143 and female workers by 3,712.

The number of casual workers of each sex is the smallest recorded since regular returns began to be made in 1921. Annual variations in the numbers of these workers are of less importance than changes in the numbers of regular workers. Perhaps, however, there is some significance in the fact that the average total number for the years 1921-26 was 20,800, while the average for the years 1927-31 is 16,500.

Acreage under each Variety of Potatoes in 1931.

A STATEMENT is printed on page 117 showing the acreages under certain varieties of potatoes in Scotland in 1931, as returned by growers of one acre or over. These returns cover 111,249 acres out of the total acreage of 128,102, the difference as in previous years being principally accounted for by the total exclusion of certain districts in the Highlands and Western Islands, and by the exclusion of holdings on which less than one acre is grown. The total acreage shows an increase of 4,744 acres as compared with 1930, and the acreage included in the returns of varieties shows an increase of 5,814 acres.

The area under First Earlies, 12,532 acres, is less by 588 acres, or 4·5 per cent., than that returned in 1930. Epicure, with 7,218 acres, or 485 acres less than last year, accounts for 57½ per cent. of the total against 58½ per cent. of the total last year. Sharpe's Express takes second place this year with 1,605 acres, although it shows a decrease of 107 acres or 6¼ per cent. Duke of York, which took second place in 1929 and 1930, comes down to third place this year with 1,539 acres, a decrease of 255 acres or 14·2 per cent. Eclipse again comes fourth with 1,255 acres, this being an increase over last year of 307 acres or 32·4 per cent. As was the case last year, these four varieties cover 92½ per cent. of the whole area under First Earlies. Herald, the new immune variety, has slightly increased from 77 acres to 82 acres.

Second Earlies, with a total acreage of 13,323, fall below last year's total by 2,039 acres. Great Scot, with a decrease of 2,243 acres, covers 7,816 acres or 58½ per cent. of the total area under Second Earlies as against 65½ per cent. last year. British

Queen, with 3,781 acres, shows an increase of 263 acres, and accounts for a further 28½ per cent. of the total area. Royal Kidney comes third this year with 370 acres, an increase of 118 acres. Arran Comrade with 280 acres and Ally with 250 acres show decreases of 51 acres and 89 acres respectively. These five varieties account for 93·8 per cent. of the total area.

The area under Maincrops, 85,394 acres, shows an increase of 8,441 acres. Kerr's Pink with 45,766 acres, an increase of 6,669 acres or 17·1 per cent., again holds first place, and covers 53·6 per cent. of the whole area. King Edward VII is again second with 14,987 acres, a decrease of 159 acres. Golden Wonder, Majestic and Arran Chief follow in the same order as last year with 9,374 acres, 6,732 and 2,296 acres respectively, the first two showing increases of 1,388 acres and 1,075 acres, while Arran Chief shows a decrease of 739 acres. These five varieties account for 92·7 per cent. of the maincrop acreage. The Up-to-date group shows a further decrease this year of 108 acres, but the new varieties, Arran Banner and Arran Consul, show increases of 91 acres and 39 acres. The other varieties do not show any significant change.

Varieties immune from wart disease cover in all 75,395 acres or 67·8 per cent. of the total area included in the return; non-immune varieties cover 35,116 acres or 31·6 per cent.; while the varieties not specified in the returns account for only 738 acres or less than 1 per cent. The percentage of immune varieties is greater than last year by 2·9, and that of non-immunes is less by the same amount. Thus the advance of the immune varieties, arrested for the first time last year, has been resumed, this year's percentage of 67·8 being the highest recorded since the returns were first taken in 1918.

Agricultural Returns, 1931.

THE abstract of the Agricultural Returns printed on pp. 118-122 shows that the total area under all crops and grass amounts to 4,632,200 acres, a net decrease of 8,518 acres as compared with 1930, the arable land being less by 19,885 acres, while the area under permanent grass is greater by 11,367 acres. The area under rye-grass and other rotation grasses and clover has increased by 35,110 acres, the decrease in the area under other crops being thus 54,995 acres.

The total area under the cereal crops is 977,817 acres, being 48,564 acres less than in 1930. The acreage under wheat shows a decrease of 3,903 acres or 7·2 per cent.; barley has decreased by 18,671 acres or 17·5 per cent., and oats by 27,025 acres or 3·1 per cent.

Beans show a small decrease and mangolds a small increase. The area under potatoes is larger by 4,744 acres or 3·8 per cent.,

but that under turnips and swedes is less by 11,368 acres or 3·1 per cent. The acreage under sugar beet has fallen from 1,663 to 955 acres, a decrease of 42·6 per cent. Cabbage shows a decrease of 243 acres or 5·1 per cent., and rape an increase of 100 acres or 0·9 per cent. The area under flax has fallen this year to 64 acres, a decrease of 11·1 per cent., after its rise to 72 acres last year from 3 acres in 1929 and 1 acre in 1928. Vetches, tares, &c. for fodder have decreased by 363 acres or 3·4 per cent.

Rye-grass and other rotation grasses and clover show an increase of 35,110 acres or 2·3 per cent., the area for hay being greater by 11,766 acres or 2·9 per cent., and that for pasture by 23,344 acres or 2·1 per cent. The area under permanent grass shows a net increase of 11,367 acres or 0·7 per cent., the area for hay being less by 5,067 acres or 3·0 per cent., but that for pasture being greater by 16,434 acres or 1·2 per cent.

The area under wheat, barley, oats and potatoes, 1,100,713 acres, is 44,855 acres less than last year, and is the lowest aggregate recorded.

The returns of live stock show that horses and cattle have decreased while sheep and pigs have increased. Horses used for agricultural purposes are less numerous by 3,010 and unbroken horses of one year and above by 596, while those under one year are less by 277. " Other horses " have increased by 235. The total decrease in all classes is thus 3,648 or 2·3 per cent. A diminution of 4,545 or 1·3 per cent. in the number of cows in milk is counterbalanced by an increase of 4,807 or 10·3 per cent. in that of cows in calf, while heifers in calf are more numerous by 768 or 1·4 per cent., and bulls by 661 or 3·9 per cent. Other cattle, two years and above, show a fall of 22,743 or 10·5 per cent., and those between one and two years old a fall of 11,287 or 3·7 per cent., but those under one year have increased by 5,187 or 2·1 per cent. The total number of cattle has thus diminished by 27,152 or 2·2 per cent. The total number of sheep shows a further advance of 181,236 or 2·4 per cent. on last year's highest recorded total, all classes showing increases. Breeding ewes have increased by 89,756 or 2·7 per cent., other sheep, one year and above, by 12,503 or 1·3 per cent., and those under one year by 76,807 or 2·4 per cent. The number of rams, 94,483, is greater than in 1930 by 2,170 or 2·4 per cent. The total number of pigs shows an increase of 18,934 or 13·2 per cent., sows being more numerous by 2,525 or 14·1 per cent., boars by 362 or 20·4 per cent., and other pigs by 16,047 or 13·0 per cent.

The acreage under rough grazings, 9,497,263 acres, is less than last year by 3,313 acres. This acreage includes 320,548 acres of deer forest land used for grazing which was formerly returned by sheep farmers as rough grazings, but which, on investigation, has been found to be actually deer forest land made available for grazing. The total figures for cattle and sheep in Scotland include 2,778 cattle and 78,579 sheep grazing

in deer forests on 4th June. Of these 699 cattle and 37,713 sheep were also included in returns made by agricultural occupiers. The relative entries in the Agricultural Returns have been cancelled, and these cattle and sheep are now brought under the heading of deer forest stock. The remaining 2,079 cattle and 40,866 sheep were not included in any Agricultural Returns, and represent the stock included on the special returns rendered by the proprietors of deer forests.

The Agricultural Returns include statistics of acreage owned by occupiers of holdings and particulars relating to poultry, but these particulars are not included in the printed abstract.

The total area of land under crops and grass returned as owned by occupiers of holdings in 1931 amounts to 1,460,446 acres as compared with 1,410,619 acres in 1930, an increase of 49,827 acres. This area is 31·5 per cent. of the whole area of land under crops and grass; in 1930 the proportion was 30·4 per cent.

The poultry figures are as follows :—

Fowls hatched before 1931	3,129,618
Fowls hatched this year	3,948,499
Ducks hatched before 1931	145,059
Ducks hatched this year	85,176
Geese hatched before 1931	8,240
Geese hatched this year	14,336
Turkeys hatched before 1931	23,903
Turkeys hatched this year	69,051

The returns of labour employed on farms are summarised at page 91.

Agricultural Conditions in 1931.

Weather.—During January the weather was generally open and mild, and farm work made good progress. The report of the Meteorological Station at Eskdalemuir, in Dumfries, states that in that district the month was the sunniest January since 1910. The weather during the first two weeks of February was changeable, frost and snow alternating with open and wet periods. The conditions improved somewhat during the second half of the month, and in some parts of the country farmers were then enabled to overtake arrears of ploughing and other seasonal work. Wintry conditions prevailed during the first half of March and outdoor work was generally impossible on account of frost; in Central Perth during this period the death-rate among early lambs was unusually heavy. Towards the end of March, however, the conditions became more open. The rain-

fall for the month was everywhere below the average, and over large areas of the country March was probably one of the driest months of that name on record. Cold, dry conditions prevailed during April and the first three weeks of May. During this period growth was retarded by low temperatures, but the weather was favourable for turnip-sowing and other agricultural operations. The following twelve weeks, extending from the last week of May to the third week of August, were distinguished by the exceptionally unsettled and wet conditions that prevailed in practically all districts. During these weeks the temperature was generally below the normal for the time of the year and there was a marked deficiency of sunshine. On 14th and 15th June the rainfall was abnormally heavy and large areas of low-lying land were flooded, while numerous sheep and cattle were drowned. As a result of these unfavourable conditions both crops and live stock made slow progress, while farm work was only carried out under difficulty. In contrast to the weather of the summer months, that prevailing during September and October was dry and mild in practically all parts of the country, several days being remarkably warm and sunny. Harvest operations were, in consequence, carried out under very favourable conditions and the crops were secured in excellent order. During November mild, wet weather was general and autumn cultivation was retarded. Root crops and grass continued to grow throughout the month.

Wheat.—The winter sowing of wheat was completed, or almost completed, before the end of December 1930, and at the beginning of January a good, healthy braird was showing on early-sown fields. The open weather of January favoured the crop, but during the first half of February and again in March growth was checked and some of the plants were discoloured by frost. The crop remained rather thin on the ground for some weeks, but the wet conditions prevalent during June appeared to stimulate the growth of the plants, and at the end of that month the crop was generally reported to have a strong and healthy appearance. Some slight damage was caused by wireworm, but speaking generally the plants were remarkably free from disease or insect pests. Ripening was delayed by adverse weather conditions during July and August. Cutting generally began during the second week of September and the work proceeded satisfactorily, so that in most cases three-quarters or more of the grain had been harvested before the end of that month. The crop was secured in very good condition and the quality of the grain is satisfactory, but some of it is small and light in weight.

Barley.—The seeding of barley was practically completed by the end of April. The crop brairded well but growth was subsequently checked by the wet, cold conditions, and at the beginning of July the plants in many fields had rather a stunted appearance. The crop made exceptionally slow progress during July

and the ears filled slowly. The plants were, however, reported to be free from disease or damage by insect pests. At the beginning of September the crop generally had a fairly satisfactory appearance, but in several areas, particularly in the eastern counties, it had been badly lodged and twisted by rainstorms. The grain ripened irregularly. Harvest began in August and generally went on with little or no interruption, but progress was rather slow owing to heavy dews and the absence of drying winds. In early districts the crop was secured before the end of September, but in later districts the work was not completed until about 10th October. In some coastal districts part of the crop was harvested before it was fully ripe. The reports on the condition of the crop were more uniformly favourable than those on the other grain crops. The quality and quantity of the grain would no doubt have been better if there had been more sunshine during the summer months, but speaking generally the grain is of fair average weight and quality and, having been stacked in exceptionally good condition, it is of good colour. The reports on bere were generally satisfactory. In the Western Islands and Orkney harvest was not wholly completed until the last ten days of October, but elsewhere very little of the grain was still in the fields after the 10th of the month.

Oats.—Sowing began at the end of March and was practically completed in good order before the end of April. The crop brairded slowly and irregularly, but the rain and rather higher temperatures that were general at the end of May benefited the plants and gave them a fresh and promising appearance. The irregularity of the braird was probably due to the fact that the previous year's harvest was carried out in bad weather and some of the seed in consequence was of rather inferior quality. Some damage by grub and wireworm was reported but, speaking generally, the crop was free from disease and pests. During the wet summer months the plants showed moderately vigorous growth but by the end of August a fairly large proportion of the crop had been lodged, more especially where the ears were at all well filled. Harvest generally began during the first and second weeks of September and was practically completed by 20th October. Cutting was rather difficult, but the crop was led in fine order and very little waste was occasioned either by shaking or by sprouting in the stook. In most areas the grain is reported to be of fully average quality and of good colour and condition, but the crop is below the average in bulk and also in bushel weight. Some of it was cut green for use as fodder.

Beans.—At the end of May beans were only just beginning to show above the ground in Berwick and Kincardine. Elsewhere the crop was then healthy and vigorous. The plants flowered well and showed an abundant growth of straw, but the lack of sunshine during June and July retarded the development

of the pods. Weeds were troublesome but the crop was remarkably free from disease and from damages by insect pests. At the beginning of September the plants had a moderately vigorous appearance. The pods were, however, late in ripening and harvest was delayed. The estimates of the yield were rather below the average in most districts, and in Stirling, which is the principal county for beans, the crop was said to be much below the average both in yield and quality. In several cases the crop was cut green for fodder or silage.

Potatoes.—In some districts the planting of first and second earlies was completed before the end of March, but the planting of maincrop varieties was not generally completed before the end of May. Most of the seed was planted under favourable conditions as regards both soil and weather. In South Ayr early crops were appearing above the ground at the end of April. Some damage was caused by frosts towards the end of May, and at the end of June it was reported that many of the plants were stunted and irregular. The lack of sunshine delayed the maturing of early varieties but the crop was reported to be of good quality. At the beginning of August disease was reported from a few scattered districts but in most cases the trouble was then not at all serious. In consequence of the humid conditions prevalent during August the blight developed rather rapidly, especially among certain varieties, and more especially in the western and south-western districts. At the end of that month disease was checked by the dry weather conditions, but unfortunately further damage was then caused in exposed districts by night frosts. A report received from North Argyll states that a few night frosts during August checked the growth of the tubers even more than the blight. Harvest generally was well forward at the beginning of November. The weather was unusually favourable for the work, which progressed rapidly, and the tubers were secured in a clean, dry condition. Reports regarding the quality and condition of the crop vary considerably. In most districts the quality is good, but the tubers are small in size and the yield is much below the average.

Turnips and Swedes.—The sowing of turnips and swedes was fairly well advanced at the beginning of June and was practically completed by the end of that month. The braird was at first reported to be strong and regular, but the unsatisfactory weather conditions during the summer retarded the development of the roots, while weeds became prevalent in most districts. "Finger-and-toe" was reported from most eastern areas, but otherwise no serious injury was caused by pests or disease. During the spell of dry, genial weather in September and October the root crops made fair progress, but not sufficient to compensate for the retarding effects of the inclement conditions that prevailed earlier in the year. On light land the crop was still growing at the end of November.

Mangolds were sown under fair conditions but they brairded slowly; at the beginning of July the thinning of the plants was carried out under difficulties owing to the wet condition of the soil. During July and August growth was hindered by the excessive rainfall, although up to a point the moisture benefited the roots. The lack of sunshine and low temperatures also had a detrimental effect upon the crop, and during the drier months of September and October the roots did not develop so well as might have been expected. The yield was generally considerably below the normal.

Sugar Beet.—The braird made slow progress, and throughout the season growth was very appreciably retarded by the lack of sunshine. The yield generally was small but the sugar content of the roots was fairly satisfactory. A report received from North-East Fife stated that in that district the sugar content varies greatly even when the roots were grown in the same field. In some fields the crop was practically a failure.

"Seeds" and Meadow Hay.—Growth was checked by cold weather during the spring months but towards the end of May the plants made good progress, and at the beginning of June there were indications that the hay crop would probably be well above the normal in bulk. Meadow grass generally showed a considerable increase in bulk just previous to cutting. Clover was rather less abundant than usual in most upland districts, but was reported to be plentiful in several areas along the eastern seaboard. South of the Tay and in a few of the earlier districts farther north harvest began at the end of June. The work proceeded slowly owing to adverse weather conditions and a considerable proportion of the crop was damaged; in some cases the crop was allowed to stand too long before it was cut, while part of the cut hay lost its bloom in consequence of exposure to the wet weather before it was secured. At the beginning of August cutting had been completed only in a few exceptionally early districts. In later districts much of the meadow grass was cut under more satisfactory weather conditions and the hay is consequently of better quality. The estimated yield per acre of hay from rotation grass and timothy meadows was in both cases well above the average of the last ten years.

Cultivation.—During October the conditions were favourable for autumn cultivation, and despite the lateness of the grain and potato harvests a good breadth of stubbles had generally been ploughed before the end of that month. Less progress was made during November in consequence of unsettled weather, but at the beginning of December the work was well forward in most arable districts. In some of the counties where wheat is extensively grown sowing began during October; in the Lothians early sown wheat had brairded before the end of the month.

Wheat sowing was completed, or practically completed, by the end of November in Fife, South-West Angus and Perth.

Live Stock.—Low temperatures retarded the growth of pastures during the early summer months. During June, July and August grass grew luxuriantly, but the quality of the herbage generally deteriorated in consequence of the wet weather. Red and white clover was still in flower at the beginning of October. Grazing cattle made rather slower progress than usual during the summer on account of the continued wet condition of the pastures. In September, however, they benefited by the improvement in the weather conditions, and at the end of November they were reported to be thriving. Dairy cows did well throughout the season and the milk yield was fairly well maintained. In Dumbarton and Dumfries, during the summer, mastitis caused a considerable amount of trouble with calving cows, while reports received from Berwick, Roxburgh and Selkirk stated that serious losses occurred through suckling cows being affected by convulsions associated with lactation, most cases having proved fatal. Lambing among flocks on arable farms was generally completed at the end of April and in most districts the fall of lambs was satisfactory. Among hill flocks the lambing season was one of the most trying for many years owing to the prevailing wet and stormy weather. At the end of June reports indicated that the continued heavy rainfall had retarded the progress of hill flocks and their condition was not up to the average. Store lambs, when marketed, were generally small and lacking in bloom. As a result of the brighter weather experienced during September and October, however, the flocks showed a general improvement all round, and at the end of November both hill sheep and those on arable farms were in good average condition. Supplies of winter keep are generally sufficient, but in several districts there is a prospect of a shortage of turnips before the end of the winter.

Labour.—The supply of regular workers during the year was adequate except for dairy hands, which were often short of requirements in the south-western counties. Casual workers for harvest were rather scarce in some districts. In the south large numbers of Irish labourers were as usual employed for harvest work.

Annual Estimates of the Produce of Crops. THE following statement regarding the produce of crops for 1931 was issued on 12th December :—

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Beans, Hay, Potatoes and Roots in SCOTLAND in the Year 1931, with

COMPARISONS for 1930, and the AVERAGE YIELD PER ACRE of the Ten Years 1921-30.

CROPS.	Estimated Total Produce. 1931.	Estimated Total Produce. 1930.	Acreage. 1931	Acreage. 1930.	Average Estimated Yield per Acre. 1931.	Average Estimated Yield per Acre. 1930.	Average of the Ten Years 1921-1930
Wheat ...	*Tons.* 48,000 *Quarters.* 223,000	*Tons.* 57,000 *Quarters.* 264,000	*Acres.* 50,024	*Acres.* 53,927	*Cwt.* 19·2 *Bushels.* 35·6	*Cwt.* 21·0 *Bushels* 39·1	*Cwt.* 21·2 *Bushels.* 38·9
Barley (including Bere) ...	*Tons.* 74,000 *Quarters.* 388,000	*Tons.* 95,000 *Quarters.* 502,000	87,900	106,571	*Cwt.* 16 8 *Bushels* 35·3	*Cwt.* 17·8 *Bushels* 37·7	*Cwt.* 17·7 *Bushels.* 37·0
Oats ...	*Tons.* 622,000 *Quarters.* 4,251,000	*Tons* 647,000 *Quarters* 4,477,000	834,687	861,712	*Cwt.* 14·9 *Bushels.* 40 7	*Cwt.* 15 0 *Bushels.* 41·6	*Cwt.* 15·0 *Bushels.* 41·0
Beans .	*Tons.* 2,600 *Quarters.* 12,200	*Tons.* 3,400 *Quarters* 15,500	3,311	3,356	*Cwt.* 15·9 *Bushels.* 29·5	*Cwt.* 20·0 *Bushels.* 36·8	*Cwt.* 18·1 *Bushels.* 33·0
Hay from Rotation Grass	*Tons* 728,000	*Tons.* 651,000	422,257	410,491	*Cwt.* 34·4	*Cwt.* 31 7	*Cwt.* 32·2
Hay from Permanent Grass .	154,000	160,000	117,433	122,113	26·2	26 3	31·4
Hay from Timothy Meadows .	111,000	108,000	48,210	48,597	46·2	44·6	43·5
Potatoes .	700,000	860,000	128,102	123,358	*Tons.* 5·5	*Tons.* 7·0	*Tons.* 6·7
Turnips & Swedes	5,438,000	5,822,000	361,328	372,696	15·1	15·6	16·8
Mangolds .	19,600	24,500	1,206	1,181	16·2	20·8	18·6

NOTE.—The total produce of wheat, 48,000 tons, is 9,000 tons less than that of 1930. The area under the crop is less by nearly 4,000 acres, while the average yield per acre, 19·2 cwt., is 1·8 cwt. under last year's figure, and 2·0 cwt. below the ten years' average. Barley, with a total produce of 74,000 tons, shows a decrease of 21,000 tons. This is much the smallest output on record. The area harvested is less than that of 1930 by 18,671 acres, and the average yield per acre, 16·8 cwt., is 1·0 cwt. less than in the preceding year, and 0·9 cwt. less than the ten years' average. The total produce of oats, 622,000 tons,

is less than in 1930 by 25,000 tons, and is the smallest since 1900. The area shows a decrease of 27,025 acres, and the average yield per acre, 14·9 cwt., is lower than that of the preceding year by 0·1 cwt. The total produce of beans amounts to 2,600 tons, or 800 less than in 1930. The average yield per acre, 15·9 cwt., is 4·1 cwt. less than in the preceding year, and 2·2 cwt. less than the ten years' average.

The total produce of hay of all kinds, 993,000 tons, is 74,000 tons above last year's total. Hay from rotation grass, with a total production of 728,000 tons, is 77,000 tons above the total of the preceding year. The area is larger than in 1930 by 11,766 acres, while the yield per acre, 34·4 cwt., is 2·7 cwt. above that in 1930, and is 2·2 cwt. above the ten years' average. Timothy meadows, with an average yield of 46·2 cwt., produced 111,000 tons, or 3,000 tons more than last year, while other meadows, with an average yield of 26·2 cwt., produced 154,000 tons, a decrease of 6,000 tons.

The outstanding feature of the returns is the further large decrease in the production of potatoes, the total being 700,000 tons as compared with 860,000 tons in 1930. The diminution is thus 160,000 tons, or 18·7 per cent., and the crop is the smallest since the disastrous year 1916. There is an increase of 4,744 acres in the area under the crop, but a decrease of 1·5 tons in the yield per acre, which is 5·5 tons as compared with 7·0 tons in 1930, and 6·7 tons for the ten years' average. Turnips and swedes, with a total produce of 5,438,000 tons, the lowest on record, show a decrease of 384,000 tons. The area is less than in 1930 by 11,368 acres, and the yield per acre, 15·1 tons, is 0·5 tons below that of 1930, and 1·7 tons below the ten years' average. The total produce of mangolds, 19,600 tons, is 4,900 tons below that of last year; the average yield per acre, 16·2 tons, is less than last year's high yield by 4·6 tons and is below the ten years' average by 2·4 tons.

Every crop, except hay from rotation grass and hay from timothy meadows, shows a reduction in the yield per acre as compared with the yield in 1930 and with the ten years' average, and also shows a smaller total produce than that of the preceding year. Barley and turnips and swedes show new low records, and oats are the smallest crop for a generation, and potatoes the smallest for fifteen years.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

The Artificial Drying of Forage Crops. *Otto Schnellbach, Agricultural Engineer. Reichskuratorium für Technik in der Landwirtschaft, Berlin.*—The problem of whether it is possible by the artificial drying of lucerne and meadow grass to obtain a concentrated green fodder rich in protein is becoming increasingly important for all countries which are obliged to import protein-rich fodder.

Artificial drying is not new. During the war large quantities of vegetables, potatoes and fodder were dried. But as soon as economic conditions returned to normal the greater part of the drying plant fell into disuse because it could no longer be worked at a profit.

In Switzerland in several places attempts have been made to cure hay artificially on various forms of racks, in drying tanks or on conveyor driers. The experiments were encouraged by the electric companies in the hope that the working of the fans and heating of the air would utilise power. But it came to be realised that in the first place electric heating cannot compete with coke unless the cost of electricity is extremely low, and in the second place the cost of the accessory electric cables is so high that the average farm is able to use electricity only for the fans and must use fuel oil or coke for heating the air.

In England large scale trials have been made of the process developed at Oxford. A fan drives hot air through hay stacked on a wire rack. Difficulties are found however in distributing the hay evenly enough for all parts to become uniformly dried. More satisfactory results have been obtained with the use of trays supplied with hot air by a portable heavy oil burner. This system has not given economic results in Germany because heating with heavy oil is too costly. The experiments have been relinquished in England and the process left to commercial development.

It is in the United States that the most practical experiments along these lines have been carried on of recent years. Mason was probably the first to develop an economically sound system of artificial dehydration and to produce lucerne meal on a commercial scale. He utilises a conveyor for passing the material through a drying tunnel approximately 150 feet long, where it is exposed to heated gases which are forced up and down through it. Mason has developed special machinery for all the operations from the cutting of the lucerne to the storage of the meal in the barn. Large mowers cut the fresh lucerne and pass it . to carts at the side. At the drier the lucerne is shot from the carts, chopped and charged on to the conveyor. The dry hay is removed at the outlet end of the tunnel, ground and driven into the storage barn by a fan.

The process has been modified slightly by Fulmer. He allows the cut grass to wilt somewhat in the swathe so that when it enters the drier it has a water content of only 50 to 60 per cent. instead of 75 to 80 per cent. There is thus considerable economy of fuel.

Several other drying installations in the United States are based on principles similar to those of Mason and Fulmer. The Arnold drier is of a different type. It is composed of three communicating drums through which the green forage is drawn by air suction. The current of air causes the small leaves, which dry rapidly, to pass through the drum more quickly than the more moist stems.

In the Koon drier the forage to be dried is driven by a fan through a system of pipes together with the heating gases. The dry parts are eliminated by a winnower, and the still moist parts come again into contact with the hot gases and are driven through more pipes.

There are a number of other driers more or less corresponding to those described. It is said that there are in all about 18 private installations for drying lucerne and hay. The products are sold mainly to poultry farmers, in Europe as well as in the United States.

In Sweden and Denmark also of recent years much attention has been paid to the question of the artificial curing of hay. The preliminary trials of the "Peco" drier, which is made in Sweden and works on the pneumatic system, have now been brought to an end. The "Hessicator" drum drier, built in

Denmark on Swedish designs, is also sufficiently advanced for its practical utility to be tried.

In Germany the first experiments with the artificial curing of hay were carried out some time before the war. The municipalities of Berlin and Friburg for some time dried the hay from the sewage irrigated meadows, which is particularly valuable on account of its high protein content. Similar experiments were tried also in Bavaria. A farmer in Silesia has adapted his whole farming system to artificial drying of forage and no longer requires to buy concentrates.

All these drying installations however supplied the direct requirements of the farm and not the general market. Artificial drying was considered rather as a protection against bad weather than as an accessory branch of agriculture. The good results obtained by poultry farms in Germany, however, by the use of meal of lucerne and grass and the increasing exportation of these meals to satisfy the demand, have led the commercial firms and research institutes in the country to devote more attention to the subject. In Germany also various different types of drying plant are in use, such as tray driers, conveyor driers, drum and pneumatic dryers. It would occupy too much space to describe in detail all these installations, for the development of forage driers is by no means at an end.

The economic utility of the artificial drying of forage crops is still contested in some quarters. It must be recognised that driers used only as a protection against bad weather cannot be profitable. Drying of crops grown on the farm may however be remunerative if the capital outlay involved is not too high. But the matter is of considerable importance in connexion with heavily manured forage crops, the full value of the high protein content of which cannot be utilised without artificial drying.

Dissemination of Finger-and-toe in the Dung of Farm Stock. *J. G. Gibbs, Mycological Laboratory, Plant Research Station, Palmerston North, New Zealand. New Zealand Journal of Agriculture, Vol. 42, No. 3, March* 1931.—An account is given of experiments carried out to ascertain whether spores consumed by stock fed with diseased material were capable of causing infection when passed out in the dung.

Conclusions drawn from the experiment showed that when the spores of finger-and-toe were consumed by sheep and cattle they were passed out in dung, and were then capable of producing the disease on any susceptible root with which they came in contact. Spores might exist in dung for a period of at least sixteen weeks without losing their vitality.

In order to grow crops free from disease farmers must prevent infection of the soil in advance of sowing, or apply large quantities of lime. Lime at economic rates had not yet been proved efficacious everywhere in New Zealand, and measures to prevent the infection of the soil were of primary importance. Precautions must also be taken to prevent infected dung being dropped on the proposed rape or turnip break. Since the spores of the club root organism were known to live in the soil for several years, precautions to prevent dissemination should be observed for at least three years before a susceptible crop is sown.

Control of Weeds with Chlorate: Further Experimental Results.—*By J. W. Deem. New Zealand Journal of Agriculture, Vol. 43, No. 2, 20th August* 1931.—For ragwort, sodium chlorate solution at from 3 to 5 per cent. strength, if reasonably applied, gives 100 per cent. kill; a further year's work fully confirmed this. It has been demonstrated that sodium chlorate is, if anything, more effective during showery weather than during particularly dry weather.

FERTILISERS.

The safe use of Industrial Nitrates of Lime.—M. Camille Matignon has made two communications to the Academy of Science of Paris (*Comptes rendus*, 1931, tome 192, p. 777, and tome 193, p. 329) on this subject. He states that the nitrates of lime now manufactured on a large scale may be transported and stored without risk. They may be heated without inconvenience even when mixed with combustible materials, which distinguishes them clearly from nitrate of ammonia.

These conclusions have been confirmed recently in an outbreak of fire at Oslo (Norway) which consumed a large wooden warehouse containing forage and 700 bags (of 100 kilos) of ammoniacal nitrate of lime (15·5 per cent. nitrogen) distributed in three lots. In consequence of the fall of burning beams and timber one of these lots was in direct contact with burning matter; the two others were exposed to only radiated heat and the upper sacks enveloping the

nitrate were charred and destroyed. In the first lot the combustion of the nitrate ' 'he top developed no particular activity and the extinguishing of the fire at this place was not more difficult.

These observations are valuable because it has been thought that the industrial nitrates of lime are capable of spontaneous ignition and for this reason certain transport companies have even imposed extra charges. This fear however is unfounded; the extra charges have been abolished and these fertilisers have been restored to the ordinary dues. Nitrate of lime may be truly dangerous only if it is mixed with combustible matter for the endothermicity of its decomposition plays a rôle similar to the heat of vaporisation of water, so that it acts as an extinguisher when the combustion remains on the surface.

It may thus be concluded that the nitrates of lime (Norwegian up to 14 per cent. and ammoniacal 15·5 per cent. of nitrogen) are not inflammable products. Moreover they cannot cause spontaneous combustion by contact of the sacks or barrels that contain them even when they are exposed to the highest temperatures in tropical regions or in ships' holds or warehouses, for no appreciable reaction of calcium nitrate on organic matter occurs below 300°C.

Trials of Micas as Potash Fertiliser in Norway.—According to the *Norsk Landmannsblat* experiments with micas which have been carried out for some years at the Agricultural College of Aas near Oslo have given very encouraging results. In certain of the trials the potash of the finely ground micas, biotite and phlogopite, had a fertilising effect equivalent to an equal quantity of potash of 40 per cent. Stassfurt salts, specially in peaty soils. On an average, however, it is admitted that 1 kg. of mica potash is equivalent to only 0·5 kg. of Stassfurt salts potash and that the micas have a rather slow action, though their action is more lasting than that of the soluble potash salts.

These experiments had in view the utilisation of the Norwegian resources of potash rich micas, particularly the abundant phlogopite deposits of Odegaardens in Telemark.

DAIRYING.

Effect of Fish Meal on the Butter-fat of Milk. *Milchw. Forsch.* 6 (4/6), 498.—In normal amounts the physical and chemical constants of the butter-fat are little affected, but the melting point and the solidification point are raised. But when the quantity of fish meal is augmented materially the structure of the butter is strongly modified, the consistency is sticky or gummy like margarine, and there is a bitter end flavour. One could not consider such butter as of good quality.

Gassy Cheese (Gouda type). *Bockhout and van Beynum. Hoorn Agric. Expt. Station Annual Report*, 1928.—Gassy curds are normally due to infection of the cheese milk with *B. col* and *B. ærogenes*, these organisms being derived from fæcal contamination or from the utensils. But gassiness which is not evident in the curd during the manufacturing process, but develops later in the cheese during ripening, is caused by the presence of butyric acid bacteria. Generally the gas is developed in the centre of the cheese, where the salt concentration is lower (Gouda cheese being made). Usually in cases of late development of gas, the acidity of the cheese undergoes reduction during the ripening process.

Dairy Control and its Organisation. *Fifteenth International Agricultural Congress at Prague and the International Milk Congress at Copenhagen*, 1931. —As a result of the report of Prof. Constantinesco (Bucharest) the Prague Congress passed the following resolutions:—

(1) That the necessary efforts should be made in all parts to make general the testing of the yield of individual cows;

(2) That the results of the tests should be entered in the herdbooks as well as on the individual records in order to complete the breed characteristics;

(3) That in order that the technique of milk yield testing and the guarantee of the authenticity of the information recorded may be effected on an international plan, a Sub-Commission of the International Agricultural Commission should be formed to study the question on the basis of the previous reports presented to the Congress; this Sub-Commission should also submit to the recommendations of the Zootechnical Section of the Scientific Council of the International Institute of Agriculture;

(4) That as close a collaboration as possible should be ensured between

practical stock breeders and zootechnical experts in order to make the best possible use of herdbook data and of the milk yield tests.

At the Copenhagen Congress a report was presented by Mr. S. Taussig (Rome) on the international organisation of dairy cow testing, in which proposals were made for international co-ordination of the technique of control in order to ensure comparable results from an international standpoint.

Ensilage and High Quality Milk.—In various regions producing hard cheeses doubts have been expressed about the possibility of using green fodder ensilage as a feed for dairy cows, and in districts aiming at the production of first quality milk there is pronounced opposition to its use. These facts led to some careful tests being undertaken to determine the influence of ensilage on milk. The results of the experiments have just been published in *Die Futterkonservierung* (Berlin, 1931, Band III, Heft 2). It is found that by the use of well-constructed silos and careful observation of the necessary precautions, young green fodder, rich in protein, can be converted by fermentation in the cold into a product containing lactic *but not butyric* acid. This form of ensilage may safely be used, as the experiments have shown, for dairy cows giving first quality milk.

ANIMAL BREEDING.

Cattle.

The Contribution of the Dam in Inheritance of Milk and Butter-fat. *By Lynn Copeland.* 1931. *Jour. Dairy Sci., Vol. XIV, No. 5, pp.* 379-393.—The thesis of the writer is that America has raised the level of the average production of dairy cattle, primarily through improved methods of feeding, better management and the elimination of low-producing animals. He further states that the results of the register of merit and herd improvement association tests do not indicate that during the past five years any material progress has been made by this means. Accordingly the writer states that it is apparent that it is to inheritance and scientific breeding methods that cattle breeders and dairymen must now look for an increase in the level of production.

In the paper under review the writer, who is dealing with advanced registry Jerseys, attempts to evaluate the importance of female ancestry. He states that there was an undoubted correlation between the production of a cow and the production of the daughters, and that therefore the selection of females from high record dams should result in a herd that would produce in excess of the breed average. He deprecates the selection of a bull purely on the record of the dam. It must be noticed that he is dealing only with the question of total butter-fat yield. The record of the dam is almost twice as reliable a measure of the production of her own daughters as it is of her sons' daughters.

The writer stresses the point that too much information cannot possibly be obtained by anybody selecting an untried young bull. Investigation should be made into the average of the dam's record, the dam's sisters' records and the dam's daughters' records. If the dam has no record, the average of the records of her maternal sisters and of her daughters gives almost equally dependable results.

Uniform Rules for the Herd Test. 1931. *Jour. Dairy Sci., Vol. XIV, No. 5, pp.* 394-397.—It is always interesting to see how other countries pursue their methods of stock improvement. Whereas in Scotland it has, for the past twenty years, been recognised that for the sake of accuracy it is important that every cow in milk-recorded herds should be tested, this is a comparatively new concept in the United States of America.

The paper under review is the production of the American Dairy Science Association, who are endeavouring to obtain some sort of uniform herd test throughout the United States. Their suggestions are interesting and if adopted would put the United States somewhat ahead of this country. Points of interest are that cows may not be milked more than three times daily and that not more than two cows shall be milked at one time, and that in no case shall the milk recorder supervise the milking of more than twenty-four cows in one day, and only sixteen if they are milked three times daily. Whenever a herd or an individual cow gives an abnormally high yield, the superintendent must be immediately informed, when another test will be conducted. An example of the requirement is that a young heifer is not expected to give more than 1·7 lb. fat in one day, while a mature cow is not expected to yield more than 2¼ lb. Surprise tests are to be conducted on much the same lines as they are in this country. The owner is expected to co-operate with the tester by furnishing

information regarding the value of milk, rations used and the local values or prices paid for feeding The milk recorder is expected to ascertain the weight and to record the amounts of all food consumed by the individual cow, and also a note of the number of tests on pasture He has to make monthly computations of food costs and income and must copy this into a herd record book, which remains in the possession of the farmer A duplicate copy is given to the Breed Association

The Influence of Environmental Temperature on the Percentage of Butter-fat in Cow's Milk. *By H J Brooks* 1931 *Jour Dairy Sci, Vol XIV, No 6, pp* 483 493—This paper reviews the subject of environmental temperature as it affects the percentage of fat in the milk It also reports a careful investigation carried out by the author of 409 cows representing four breeds of cattle, Holstein, Ayrshire, Jersey and Guernsey In order to counteract the variable causes according to the month of calving, the author managed to arrange for an equal number of cows of each breed to calve each month, the figure being approximately nine for each breed per month The results show clearly that environmental temperature exerts a greater influence upon the percentage of butter fat of cows milk than does the stage of the lactation The lower the temperature the higher the percentage of butter fat, whilst the higher the temperature the lower the percentage of butter fat That the change in the percentage of butter fat is not due to an alteration in the total yield of milk is shown by the figures For instance as regards the four seasons the highest yield of milk per day, namely 26 2 lb which occurred in the spring, was accompanied by 1 06 lb of butter fat, making 4 per cent with the temperature at 54° F In summer the average yield of milk per day was 24 7 lb with an average yield of fat of 0 96 lb making 3 8 per cent at a temperature of 76° F, while for winter the average yield of milk per day was 23 7 the average yield of fat was 1 0, giving a percentage of 4 2 at an average temperature of 35

Wastage in Dairy Cows. 1 *Annual Report of the Scottish Milk Records Association*, 1931, *pp* 78 81 2 *Report of the Director General, Department of Agriculture, New Zealand*, 1931 *page* 3—Through the co operation of the Scottish Milk Records Association and the assistance of milk recorders in Scotland in January 1930 an enquiry was begun to determine the proportion of milking stock annually drafted out of typical dairy herds in Scotland and to find out the cause of disposal of milking stock The information was collected from 190 milk recorded herds which was based on the disposal of more than 3 600 milking animals Of the total number of disposals 16 6 per cent were drafted out of the herds on account of low milk yield This figure emphasises the value of milk recording in determining the relative value of animals in the herd, and hence in weeding out unsatisfactory milking stock Disease disposals constituted 44 per cent of the total 7 6 per cent of the total disposals were due to tuberculosis, 15 per cent to udder disease and 19 3 per cent to reproductive disease

The second report is based on a similar survey conducted by the herd testing officers in the Dominion of New Zealand who examined 2 517 dairy herds containing 128,000 cows There was a wastage from these herds from all causes during the 1929 1930 season of 10 7 per cent Of the total disposals 35 per cent were on account of sickness or disease including breeding troubles while 50 per cent were on account of low production again emphasising the value of milk recording as a means whereby breeders may increase the productivity of their herds

A recent report by Dr Sanders of Cambridge based on reports of milk recorders in 540 herds states that sterility was found to be the chief cause of loss, and this was closely followed by low milk yields

Goats

The Management of Milch Goats. *S Leigh Hunt J Min Agric (Eng)*, 1931, 38, 724 731—The paper briefly outlines the general management of goats and offers advice on the purchase of a foundation for the herd Especial stress is laid upon the desirability of obtaining animals with long lactation periods, rather than individuals which may produce a higher yield for a shorter period The highest yields officially recorded for goats (5,050 lb 15 ozs in the recorded year ended October 1st, 1930, 4,067 lb 2 ozs for a first kidder and 21 lb 6 ozs in 24 hours) are mentioned The breeds of goats found in Great Britain are enumerated, the "British" types being recommended Advice on breeding is offered, and the great value of the Ministry's Stud Goat Scheme in improving the stock of smallholders and others is pointed out The rearing of

kids, milking and recording, housing and feeding are dealt with, and two suitable food mixtures are given. This useful article concludes with a note on goats' butter, cheese and manure, but no reference is made to the flesh of kids as an article of food.

ANIMAL NUTRITION.

Feeding Wheat to Live Stock.—As stated in the *Agricultural Gazette of New South Wales* (April 1931) by S. L. Black, a considerable amount of attention is at present being given to the possibility of making profitable use of wheat as a food for live stock in New South Wales. The writer refers to a number of experiments made in different countries on this subject, and concludes that ruminants are in better position to deal satisfactorily with the grain on account of the preparation which the food has undergone before having entered the fourth or true stomach. Wheat may, nevertheless, be fed to *horses* to advantage provided due discretion is exercised in its use. Wheat can be used as a sole concentrate for *dairy cows* if some nitrogenous bulky food is given, such as lucerne chaff or other legume. Mixed concentrate is, however, to be preferred. As in the case of horses it should be fed to cattle not whole but as ground or rolled wheat. As a portion of the ration of *fattening cattle*, wheat has given better results than oats. Wheat is preferably fed whole to *sheep*. In America it is considered slightly superior to maize for these animals, but in New South Wales the experience is that maize gives better results. For young and growing *swine* wheat is much superior to corn. For fattening purposes they are about equal, but the quality of bacon produced from wheat-fed pigs is considered superior. Whole wheat constitutes a valuable grain ration for *poultry* and can be used either alone or mixed with cracked corn.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in September, October and November, 1931.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	September.			October.			November.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK :—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt s. d	per cwt s. d.	per cwt. s. d.	per cwt s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	56 9	50 7	42 5	57 8	49 11	42 0	57 8	48 8	42 0
Cross-bred (Shorthorn)	52 2	45 5	36 2	52 3	45 3	34 8	51 11	44 3	34 2
Galloway	46 2	42 7	...	45 8	41 9	..	44 3	40 11	...
Ayrshire	46 10	40 2	31 10	44 6	38 6	33 3	42 9	36 6	32 0
Blue Grey	49 6	...	...	...	. .	...	...	...	...
Highland	48 6	..	...	47 0	...	...	...	...	...
	per lb. d.	per lb d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	14	9	. .	14	9	...	15	9	...
	Hoggs under 60 lb.	60 lb and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.
†SHEEP—	per lb. d.	per lb. d.	per lb d.	per lb. d.	per lb d	per lb. d.	per lb. d	per lb. d.	per lb. d.
Cheviot	11½	9	7½	10¾	9	7½	10¼	8¼	7
Half-bred	11	9½	6¾	10¾	9	6¾	10	8¼	6½
Blackface	11	9½	7¼	10¾	9	7¼	10¼	8¾	7
Greyface	11¼	9¾	7	10¾	9	6¾	10½	8¾	6¼
Down Cross	10¾	9½	6	10¾	9½	5¾	10¼	9¾	5½
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.
Bacon Pigs	9 1	8 4	...	9 1	8 3	...	8 10	7 11	.
Porkers	10 3	9 8	...	10 4	9 1	...	10 2	8 11	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	September.			October.			November.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
CATTLE—	Per head.	Per head.	Per head	Per head.	Per head.	Per head.	Per head	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	15 13	12 6	11 10	16 12	12 17	11 0	15 10	12 6	10 16
Two-year-olds ...	21 18	17 3	14 15	21 14	17 9	15 0	21 7	16 14	14 9
Cross-bred (Shorthorn) :									
Yearlings	14 19	11 7	10 10	15 15	12 10	10 10	14 13	11 10	10 5
Two-year-olds ...	20 18	16 7	14 5	21 0	16 9	14 4	20 6	16 1	13 19
Galloway :									
Yearlings	15 3	12 5	...	15 5	11 0	...	13 11	. .	...
Two-year olds ..	20 12	17 10		20 18	17 11	...	24 0	15 0	...
Ayrshire									
Yearlings .. .	11 8	9 0	..	11 8	12 0	...	9 15	...	...
Two-year-olds ..			..	17 3	14 10	...	...	...	..
Blue Grey :									
Yearlings . ..	. .	. .	...	...		. .	..	...	...
Two year-olds ...	22 15	..		21 10	...	...	20 15	. .	...
Highland :									
Yearlings .	11 10	9 15	7 0	10 5	8 5	6 14	9 2	8 15	6 15
Two year-olds .	15 0	13 5	11 0	14 13	11 18	10 10	13 14	11 9	10 3
Three-year-olds .	17 10	15 5	12 10	16 19	14 10	12 10	...	15 3	12 18
DAIRY COWS—									
Ayrshire									
In Milk	28 16	20 7	12 0	27 6	20 3	12 0	28 17	21 1	12 0
Calvers	26 4	19 13	14 5	26 7	20 8	14 16	28 4	20 2	14 10
Shorthorn Cross									
In Milk	30 16	23 2	19 10	31 8	22 15	..	31 0	23 13	...
Calvers .. .	29 15	20 10	16 11	28 19	20 16	17 11	30 8	21 15	16 2
SHEEP—	s. d.	s. d	s. d	s. d.	s. d	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ..	...	23 3	...	42 6	25 0	...	...	...	...
Half-bred Hoggs ..	32 0	24 0	...	.	...	...	34 3	15 11	...
Blackface Hoggs ..	22 0	20 9	. .	24 6	16 9	...	21 1	14 6	...
Greyface Hoggs ...	41 10	32 5	. .	34 10	25 0	...	31 8	24 3	...
Down Cross Hoggs	39 3	28 0	. .	34 6	27 6	...	28 11	24 0	. .
PIGS—									
(6 to 10 weeks old)	24 7	15 9	...	24 2	15 6	...	22 11	14 2	...

Dead Meat: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	September. Dundee.	September. Edinburgh.	September. Glasgow.	October. Dundee.	October. Edinburgh.	October. Glasgow.	November. Dundee.	November. Edinburgh.	November. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Beef:—										
Home-fed—										
Bullock or Heifer ...	1	9	8⅝	9¾	8½	7⅞	9½	8⅝	7½	9½
	2	8½	...	8⅛	8	7	8¼	8	...	8
Bull	1	7	6¾	6⅝	6½	6¼	6⅝	6⅝	6¼	6½
	2	6½	...	6	6	...	5⅞	6	...	5½
Cow	1	5⅝	5⅝	5⅞	5½	5⅝	5¾	5½	5⅛	5½
	2	5	...	4⅛	5	...	4½	5	...	3⅝
Irish—										
Bullock or Heifer ...	1	...	...	7⅞	...	...	7⅞	...	...	7⅜
	2	...	...	7¼	...	...	7⅜	...	...	6⅝
Argentine Frozen—										
Hind Quarters ...	1	4⅝	7⅛	...	4½	6⅞	...	4⅝	6½	...
	2	4½	4⅝	...	...	4⅜	...	4¼	4¼	...
Fore ,, ...	1	3⅛	4	...	3½	3¾	...	3⅝	3¾	...
	2	..	3¼	..	...	3⅛	...	3	3⅛	...
Argentine Chilled—										
Hind Quarters ...	1	7⅝	7⅝	7¼	7¼	7⅜	6½	6⅝	6¼	6⅜
	2	7	7	6⅜	6¾	6⅞	5¾	5⅞	5⅞	5½
Fore ,, ...	1	4⅛	4⅛	3¾	4⅛	4	4	4	3⅞	3¾
	2	4	3⅝	3⅜	...	3⅛	3⅝	3¾	3⅝	3½
Australian Frozen—										
Hind Quarters ...	1	...	...	3⅞	...	...	4⅛	...	...	4¼
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	3	...	...	3¼	...	...	3¼
New Zealand Frozen—										
Hind Quarters ...	1	..	...	3⅛	...	...	4	...	...	4¼
	2	..	...	...	...	...	...	...	...	...
Fore ,, ...	1	...	..	2¾	...	...	3¼	...	...	3⅛
	2	...	...	...	...	...	..	...	...	...
Mutton:—										
Hoggs, Blackface ...	under 60 lb.	11½	9⅞	10⅛	11	9⅞	10	11	8⅞	9⅝
	60 lb. & over	10¾	..	9⅝	10	..	9	10	...	9
,, Cross	under 60 lb.	11½	9⅛	10⅛	11	9⅞	10	11	8⅞	9⅝
	60 lb. & over	10¾	..	9⅞	10	...	9	10	...	9
Ewes, Cheviot	1	...	6⅝	6⅝	...	5⅝	6⅛	...	5	5⅝
	2	...	...	6⅛	...	...	5½	...	...	5⅛
,, Blackface ...	1	8	6⅝	6⅝	7	5⅞	6⅛	7	5	5⅝
	2	7¼	...	6⅛	6	...	5½	6	..	5⅛
,, Cross	1	6	6⅝	6⅝	5	5⅝	6⅛	5	5	5⅝
	2	5	...	6⅛	...	...	5½	...	...	5⅛
Argentine Frozen ...	1	...	...	5	..	...	5¼	...	...	4½
	2	...	...	...	...	...	...	...	...	...
Australian ,, ...	1	...	5⅝	4⅝	...	4¼	5	...	4	3⅛
	2	...	4½	...	...	3½	...	...	3	...
New Zealand ,, ...	1	...	...	5⅛	...	...	5¼	...	...	4⅞
	2	...	...	4¾	...	...	4⅞	...	...	4⅝
Lamb:—										
Home-fed	1	12	10⅝	10½	...	...	10⅛	...	...	9¼
	2	...	...	9⅞	...	...	10	...	...	9
New Zealand Frozen ...	1	...	9	7⅞	...	8¾	8½	...	7¾	7⅝
	2	...	8⅛	7⅛	...	6⅞	8¼	...	6¼	6⅝
Australian ,, ...	1	...	...	7⅛	...	...	7½	...	...	6¾
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ...	1	...	...	6	...	...	6	...	...	5⅝
	2	...	...	5⅝	...	...	...	...	...	...

Market.	Description.	Quality.	September.	October.	November.
			s. d.	s. d.	s. d.
Aberdeen.	Country ... ... per doz.	1	1 7	1 10	2 5
		2	1 6	1 8	2 4
	Duck .. ... ,,	1	1 7	1 10	2 5
		2	1 6	1 9	2 4
Glasgow.	Country .. ... per doz.	1	1 9	2 2	2 10
		2	1 8	1 11	2 7
	Irish .. ... per 120.	1	15 11	20 3	26 10
		2	14 4	16 9	24 1
	,, (Duck) ... ,,	1	13 1	14 2	16 5
	,, (Cold Stored) ... ,,	1	12 0	11 8	12 7
	,, ,, ... ,,	2	11 6	...	12 2
	American ... ... ,,	1	...	..	14 8
	Argentine ... ... ,,	1	12 6	...	12 7
	Australian ... ... ,,	1	13 9	13 9	16 6
	,, ... ,,	2	...	13 3	15 7
	Belgian ... ... ,,	1	13 0	14 8	19 0
	Canadian ... ... ,,	1	...	13 4	13 7
	Danish ... ... ,,	1	12 9	14 6	18 10
	Dutch ... ... ,,	1	12 5	13 0	13 0
	Polish ... .. ,,	1	8 2	9 4	9 9
	,, ... ,,	2	6 4	8 5	8 0

Description.	Quality.	September.	October.	November.
		s. d.	s. d.	s. d.
BUTTER:				
Irish Creamery ... ... per cwt.	1	122 0	124 3	124 4
,, ,, (Unsalted) ,,	1	126 10	130 0	130 0
Australian ... ... ,,	1	115 7	122 9	116 9
Canadian ... .. ,,	1	116 0	118 3	116 3
Danish ... . ,,	1	132 2	137 6	134 6
,, (Unsalted) ... ,,	1	137 2	142 6	139 6
New Zealand . ... ,,	1	120 7	126 9	121 3
,, (Unsalted) ... ,,	1	127 0	130 3	126 0
Siberian ... . ,,	1	104 5	111 6	107 0
Swedish ... . ,,	1	125 7	130 9	129 6
CHEESE:				
Cheddar ... ... ,,	1	76 5	83 0	88 0
,, ... ,,	2	73 7	79 0	84 6
Cheddar Loaf ... .. ,,	1	91 2	93 6	96 6
,, ,, ... ,,	2	89 2	90 6	92 6
Dunlop ... ... ,,	1	72 0	80 0	87 0
,, ... ,,	2	67 2	76 0	82 6
Canadian .. .. ,,	1	68 7	74 0	75 0
New Zealand (Coloured) ,,	1	68 10	74 3	74 0
,, (White) ,,	1	...	...	74 0
HAMS:				
Irish (Smoked) ... ... ,,	1	147 0	139 6	134 6
,, ,, ... ,,	2	135 0	125 0	121 9
American, Long Cut (Green) ,,	1	94 5	95 6	80 6
,, Short Cut ... ,,	1	85 10	89 3	74 3
BACON:				
Ayrshire (Rolled) ... ,,	1	103 7	100 6	94 3
Irish (Green) ... .. ,,	1	80 10	81 0	75 6
,, (Dried or Smoked) ,,	1	87 7	85 6	82 6
,, (Long Clear) ... ,,	1	86 0	84 6	80 0
Wiltshire (Green) ... ,,	1	96 0	93 0	90 0
,, (Dried or Smoked) ,,	1	102 0	99 0	96 0
Danish, Sides ... ... ,,	1	69 2	66 0	58 0
Dutch, Green (Wiltshire Style) ,,	1	62 5	61 3	53 0
Polish, Green ,, ,, ,,	1	60 0	58 3	49 6
American (Short Clear Backs) ,,	1	78 10	78 6	76 0

Fruit and Vegetables: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.		Quality.	September.	October.	November.
Fruit:—					
Apples—			s. d.	s. d.	s. d.
English, Cooking	... per cwt.	1	*17 0	19 0	20 0
American ...	... per case.†	1	12 5	12 9	12 3
,, ...	... per barrel.**	2	18 2	22 5	23 8
Pears, Californian	... per case.†	1	16 11	14 9	19 0
Blackberries ...	... per lb.	1	0 5½	0 5¾	...
Damsons ...	... ,,	1	0 4¼	0 6	...
Plums, Monarch	... ,,	1	0 4	..	...
,, Victoria	... ,,	1	0 4¼	...	...
Vegetables:—					
Beans—					
Dwarf ...	.. per lb.	1	0 4¾	...	...
Scarlet Runner	... per stone.	1	2 0	...	...
Beet	... per cwt.	1	6 9	7 3	9 0
Brussels Sprouts	... ,,	1	‡8 10	14 0	12 0
Cabbage, Coleworts	... per doz.	1	1 7	1 6	1 6
,, Red	... ,,	1	3 6	4 0	3 5
,, Savoy ...	.. ,,	1	2 5	2 0	1 9
Carrots, ...	... per cwt.	1	5 6	6 0	6 0
Cauliflowers—					
Broccoli, Cornish	... per doz.	1	...	4 0	4 0
Other British ..	... ,,	1	4 4	2 6	2 6
French ...	... ,,	1	...	...	4 2
Celery	... per bunch.	1	2 3	1 11	1 9
Cucumber ...	... per doz.	1	4 1	6 5	7 3
Greens	per doz. bunches.	1	8 0	7 3	8 0
Leeks ...	,, ,,	1	2 10	2 6	2 6
Lettuce, Cos ...	... per doz.	1	1 0	1 0	1 0
,, Cabbage	... ,,	1	1 0	1 0	1 0
Onions, *Spring* ...	... per bunch.	1	0 4½	...	...
,, *Dutch* ...	... per cwt.	1	6 4	6 3	7 8
,, *Valencia*	.. per case.**	1	8 6	9 9	9 5
Parsley	... per cwt.	1	12 0	11 6	12 6
Parsnips	... ,,	1	9 5	8 6	8 0
Peas	... ,,	1	16 0	13 4	...
Radishes	per doz. bunches.	1	1 6	1 6	1 8
Rhubarb	... per cwt.	1	4 0	...	...
Spinach	... per stone.	1	4 0	4 0	3 11
Tomatoes—					
Scottish, National mark, "A. A"	per lb.	1	0 6¼	0 6¾	0 8¼
,, ,, ,, *Medium*	per lb.	1	0 5¾	0 6¼	0 7¾
Other Scottish ...	,,	1	0 5¾	0 6¼	0 7½
Channel Islands ...	,,	1	0 2¾	0 2¾	0 3
Dutch	,,	1	0 2¼	0 2¼	0 2½
Turnips	... per cwt.	1	2 11	2 8	2 6
Vegetable Marrow	... per doz.	1	3 7	5 3	4 4

* 56 lb. † 40 lb. (approx.). ** 9 stone. (approx.). ‡ per bag (3 stone).

POTATOES: Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Golden Wonder.	Late Varieties. Other Soils. Other.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
SEPTEMBER.							
Aberdeen, per ton	1	...	5 15 0	...	...	...	6 0 0
Dundee ,,	1	5 10 0	5 10 0	...	...	...	5 10 0
Edinburgh ,,	1	6 10 0	6 10 6	...	...	10 0 0	6 13 4
Glasgow ,,	1	6 5 0	6 6 0	...	...	...	6 18 0
OCTOBER.							
Aberdeen ,,	1	...	...	...	...	...	6 17 6
Dundee ,,	1	...	.	...	...	...	6 5 0
Edinburgh ,,	1	...	7 7 6	...	...	...	...
Glasgow ,,	1	...	6 8 9	...	...	...	6 15 0
NOVEMBER.							
Aberdeen ,,	1	...	..	...	...	9 1 8	7 0 0
Dundee ,,	1	...	...	...	...	.	6 10 0
Edinburgh ,,	1	...	7 8 9	...	...	10 17 6	7 8 9
Glasgow ,,	1	...	6 15 0	.	...	9 10 0	7 1 3

ROOTS, HAY, STRAW AND MOSS LITTER: Monthly Average Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Oat.	Straw. Barley.	Moss Litter.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
SEPTEMBER.										
* Aberdeen, per ton	1	...	...	...	64 0	...	...	40 0	...	...
‖ Dundee ... ,,	1	...	17 8	...	90 6*a* 82 0*b*	...	65 0	65 0	...	40 0†
¶ Edinburgh ,,	1	...	...	...	65 0*b*	...	57 6	49 0	50 0	...
a Glasgow ,,	1	...	...	...	68 0	73 0	45 0	40 0	..	33 0§
OCTOBER.										
* Aberdeen ,,	1	...	...	..	53 9	...	...	37 6	...	...
‖ Dundee ... ,,	1	...	18 0	...	83 9*a* 71 3*b*	...	65 0	65 0	..	41 3†
¶ Edinburgh ,,	1	...	...	...	72 6*a* 65 0*b*	...	47 6	45 0	45 0*a*	...
a Glasgow ,,	1	...	...	...	60 0	65 0	45 0	40 0	...	32 6§
NOVEMBER.										
* Aberdeen ,,	1	...	...	...	55 0	...	...	35 0	...	...
‖ Dundee ... ,,	1	...	18 0	22 6	88 9*a* 78 9*b*	...	60 0	60 0	...	...
¶ Edinburgh ,,	1	...	...	...	72 6*a* 65 0*b*	...	45 0	45 0	...	...
a Glasgow ,,	1	...	...	...	60 0	65 0	45 0	40 0	...	32 6§

* Loose, ex farm. *a* Delivered baled. *b* Delivered loose.
† Granulated moss litter; in 4 ton lots, at Dundee station. ‖ Baled straw, delivered.
§ Home moss litter, in $1\frac{1}{2}$ cwt bales. ¶ Bunched straw, delivered.

FEEDING STUFFS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	September.		October.		November.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	8 6 9	7 17 0	8 7 6	8 1 3	9 0 0	8 12 6
Foreign	8 0 6	6 18 4	8 2 2	...	8 8 5	...
Decort. Cotton Cake	7 5 0	...	7 6 8	...	...	...
Undecorticated do.—						
Bombay (Home-manufactured)...	...	4 11 11	...	5 3 9	...	5 13 2
Egyptian (do.)	5 0 6	5 4 0	5 15 0	5 15 0	6 3 2	6 0 0
Palmnut Kernel Cake	6 18 0	...	7 10 0	...	8 0 0	...
Soya Bean Cake ...	8 5 0	7 7 0	9 6 3	7 13 4	9 12 6	8 3 9
Coconut Cake ...	8 1 0	...	8 0 0	...	8 3 9	...
Groundnut Cake, Undecorticated—						
(36/37 per cent. Oil and Albuminoids)	5 3 0	...	5 11 3	...	6 1 11	...
(39/40 per cent. do.)	5 7 6	..	5 15 0	...	6 6 3	...
Maize Germ Cake—						
Home	7 12 0	...	7 17 6	...	8 2 6	..
Foreign	6 17 0	...	7 5 0	.	8 0 0	..
Maize Germ Cake Meal	5 7 6	..	5 16 11	..	6 4 5	..
Rice Meal	4 12 6	4 12 6	5 9 8	4 17 6	5 16 11	..
Bean Meal	8 10 3	8 10 0	8 9 5	8 10 0	8 13 9	8 18 9
Barley Meal ...	6 14 6	6 11 8	6 16 3	6 16 3	7 4 5	7 3 9
Fish Meal	15 10 0	15 5 0	15 2 6	15 2 6	15 10 8	15 5 0
Maize Meal—						
Home-Manufactured	5 4 0	4 18 0	5 13 2	5 10 0	6 10 0	6 11 3
South African—(Yellow) ...	5 3 9	..	5 10 11	...	6 3 2	...
Locust Bean Meal (Fine)	6 2 3	5 1 0	6 4 8	5 6 3	6 8 2	5 15 0
Maize Gluten Feed (Paisley)	5 6 6	...	5 10 0	..	6 5 0	.
Maize—Plate ...	4 4 11	4 3 6	4 13 9	4 11 3	5 12 6	5 12 6
Do. African, Flat	...	...	6 10 0	...	6 10 0	..
Oats—Home ...	7 19 6	7 11 0	8 10 8	7 17 6	8 16 3	8 7 6
Do. Plate ...	4 15 6	...	6 1 7	6 5 0	7 3 5	6 13 9
Do. Canadian No. 2	6 10 0	...	7 1 8	.	..	.
Barley, Feeding (Home)	6 1 7	6 0 0	6 10 0	5 18 9	6 13 9	6 10 0
Wheat—						
Home	6 11 9	5 12 6	7 4 5	6 6 11	8 7 2	7 6 3
Poultry	5 14 6	...	6 16 3	...	7 8 9	...
Imported... ...	6 3 6	...	6 18 2	...	7 15 0	.
Middlings (Fine Thirds or Parings)	6 5 6	6 0 0	6 14 5	6 6 3	7 0 0	6 14 5
Sharps (Common Thirds) ...	5 0 9	5 0 0	5 13 2	5 10 0	6 5 11	6 5 0
Bran (Medium) ...	4 15 9	4 15 6	5 12 2	5 11 3	6 5 8	6 5 0
,, (Broad) ...	4 18 9	5 12 6	5 16 3	6 8 2	6 8 5	7 1 3
Malt Culms... ...	3 16 0	3 16 3	4 0 0	4 5 8	4 12 6	4 18 4
Distillery Mixed Grains—Dried	...	6 16 3	...	6 15 0	...	7 5 0
Brewers' Grains—Dried	4 17 0	4 15 6	5 7 6	5 3 9	6 10 11	5 18 9
Distillery Malt Grains—Dried	6 11 0	...	6 15 0	...	6 18 9	...
Crushed Linseed ...	16 0 0	...	16 0 0	...	15 10 0	...
Locust Beans, Kibbled and Stoned	5 2 3	4 12 6	5 8 2	4 18 2	5 10 11	5 5 0
Beans—China ...	6 18 9	...	7 10 11	...	8 1 11	8 2 6
Do. Rangoon (White)	6 2 0	...	6 11 3	...	7 0 0	...
Pease, Karachi (do.)	6 14 9	...	7 5 0	...	...	...
Feeding Treacle ...	4 17 6	5 7 6	4 17 6	5 7 6	4 17 6	5 7 6
Linseed Oil, per gall.	0 3 3	...	0 3 3	...	0 3 3	...

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	SEPTEMBER.		OCTOBER.		NOVEMBER.	
		Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
		per ton.	per ton.	per ton.	per ton.	per ton.	per ton.
	%	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Nitrate of Soda * ...	N. 15·5	7 18 0	7 18 0	...	...	8 10 0	...
Sulphate of Ammonia (Neutral and Granular) * ...	N. 20·6	5 13 0	5 16 0	6 6 3	6 5 0	6 10 0	6 10 0
Nitrochalk * ...	N. 15·5	6 5 0	...	7 5 0	7 5 0	7 5 0	7 5 0
Calcium Cyanamide †	N. 20·6	6 17 0	...	6 5 0	...	6 10 0	...
Superphosphate ...	P.A. 13·7	2 16 3	2 15 0	2 14 1	2 15 0	2 7 6	2 15 0
" ...	" 16·0	3 2 6	3 0 0	3 0 0	3 0 0	2 12 6	3 0 0
" ...	" 18·3	3 7 6	3 5 0	3 6 3	3 5 0	3 2 6	3 5 0
Ground Mineral Phosphate ‡	P.A. 26	...	2 5 0	...	2 5 0	...	2 5 0
" " " §	" 26	2 7 6	...	2 7 6	...	2 7 6	...
" " " ‡	" 34	...	3 5 0	..	3 5 0	...	3 5 0
" " " §	" 34	3 7 6	...	3 7 6	...	3 7 6	...
Potassic Mineral Phosphate	P.A. 18, Pot. 9	3 8 9	...	3 8 9	...	3 8 9	...
" " "	P.A. 21, Pot. 6	3 3 9	...	3 3 9	.	3 3 9	...
Kainit (in bags) ...	Pot. 14	*a* 3 1 0	...	*a* 2 16 11	...	2 18 2	...
Potash Salts ...	Pot. 20	*a* 3 11 0	...	*a* 3 10 0	...	3 8 9	...
" " ...	Pot. 30	*a* 4 13 11	...	*a* 4 12 10	...	4 12 6	...
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	*a* 8 12 0	...	*a* 8 10 0	...	8 11 3	...
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	*a* 10 10 8	...	*a* 10 7 6	...	10 8 9	...
Steamed Bone Flour	N. 0·8, P.A. 28	4 17 0	...	4 15 0	5 5 0	5 2 6	5 5 0
Bone Meal (Home)	N. 3·3, P.A. 22·9	6 15 0	..	6 15 0	...	6 15 0	...
" " (Indian)	N. 4, P.A. 19/20	6 17 0	...	7 0 0	...	7 0 0	...
Basic Slag ‖ ...	P.A. 11	1 19 0	...	1 19 0	...	1 19 0	...
" " ...	" 12	2 1 6	...	2 1 6	...	2 1 6	...
" " ...	" 13	2 4 6	...	2 4 6	...	2 4 6	...
" " ...	" 14	2 7 0	1 15 6	2 7 0	1 15 6	2 7 0	1 15 6
" " ...	" 15·75	...	2 0 0	2 11 0	2 0 0	2 11 0	2 0 0
" " ...	" 16·5	...	...	2 14 0	...	2 14 0	...
" " ...	" 17·5	...	...	2 18 0	...	2 18 0	...

Abbreviations:—N. = Nitrogen ; Pot. = Potash ; P.A. = Phosphoric Acid.

* Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

‡ 85 to 90 per cent. fineness through standard 100-mesh sieve.

§ 90 per cent. fineness through prescribed sieve.

‖ Prices for Basic Slag are:—At Glasgow—F.o.r., in 6-ton lots, 80 per cent. citric soluble; at Leith—F.o.r., Grangemouth.

a Less 5*s.* per ton ex quay.

Statement showing the Acreage under each Variety of Potatoes in Scotland in 1931.

Variety.	Acres.
A. First Earlies.	
1. *Dargill Early	68
2. *Di Vernon	62
3. *Herald †	82
4. *Immune Ashleaf ...	70
5. *Snowdrop (including Witch Hill)	67
6. Beauty of Hebron (including Puritan) ...	93
7. Duke of York (including Midlothian Early and Victory)	1,539
8. Eclipse (including Sir John Llewelyn) ...	1,255
9. Epicure	7,218
10. May Queen	111
11. Ninetyfold	215
12. Sharpe's Express ...	1,605
13. Other First Earlies not specified above ...	147
Total First Earlies ...	12,532
B. Second Earlies.	
14. *Ally	250
15. *Arran Comrade	280
16. *Ben Lomond	146
17. *Catriona	125
18. *Edzell Blue	248
19. *Great Scot	7,816
20. *King George V	190
21. British Queen (including Pioneer, Macpherson, Maid of Auchterarder, &c.)	3,781
22. Royal Kidney (including Queen Mary)	370
23. Other Second Earlies not specified above ...	117
Total Second Earlies	13,323
C. Maincrops.	
24. *Sutton's Abundance (including Culdees Castle, Kerr's New White, Twentieth Century, Just in Time, &c.) ...	784
25. *Arran Banner †	769
26. *Arran Consul †	656
27. *Arran Victory	315
28. *Bishop	39
29. *Champion	466
30. *Crusader	44
31. *Early Market	23
32. *Golden Wonder (including Peacemaker) ...	9,374
33. *Irish Queen	468
34. *Kerr's Pink	45,766
35. *Langworthy (including Maincrop and What's Wanted)	275
36. *Majestic	6,732
37. *Rhoderick Dhu	155
38. *Tinwald Perfection ...	125
39. Arran Chief	2,296
40. Field-Marshal	450
41. King Edward VII (including Red King) ...	14,987
42. President (including Iron Duke and Scottish Farmer)	109
43. Up-to-Date (including Dalhousie, Factor, Glamis Beauty, Scottish Triumph, &c.) ...	1,087
44. Other Maincrops not specified above ...	474
Total Maincrops ...	85,394
Total Area Classified, ...	111,249
Acreage Not Included, ...	16,853
Total Acreage Grown, ...	128,102

Notes.—(1) The following districts are excluded :—In the county of Inverness—Skye, Harris, North and South Uist; in the county of Ross and Cromarty—Western, South-Western, Lewis.
(2) Returns showing a total area of less than one acre under potatoes are not tabulated.
(3) Varieties marked thus * are immune from Wart Disease.
(4) Varieties marked thus † have been registered by the Department of Agriculture for Scotland as new varieties.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1931.

Collected 4th June 1931 (and comparison with 1930).

CROPS.

Distribution.	1931.	1930.	Increase.		Decrease.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
Total Area (excluding Water)	19,069,067	19,069,007	..	..	..	..
Mountain and Heath Land used for Grazing (*b*)	9,497,263	9,500,576	..	..	3,313	0·03
Total Acreage under Crops and Grass	4,632,200	4,640,718	..	..	8,518	0·2
Arable Land	3,051,930	3,071,815	..	..	19,885	0·6
Permanent Grass (*a*) — For Hay ..	165,643	170,710	..	..	5,067	3·0
Permanent Grass (*a*) — Not for Hay .	1,414,627	1,398,193	16,434	1·2	.	..
Permanent Grass (*a*) — Total ..	1,580,270	1,568,903	11,367	0·7	..	..
Wheat	50,024	53,927	..	..	3,903	7·2
Barley (including Bere)	87,900	106,571	..	..	18,671	17·5
Oats	334,687	361,712	..	..	27,025	7·5
Mixed Grain	2,044	1,060	984	92·8	..	..
Rye..	3,162	3,111	51	1·6	..	..
Beans (to be harvested as Corn) .. .	3,311	3,356	..	..	45	1·3
Peas	420	357	63	17·6	..	..
Potatoes	128,102	123,358	4,744	3·8	.	..
Turnips and Swedes	361,328	372,696	..	..	11,368	3·1
Mangolds	1,206	1,181	25	2·1	..	..
Sugar Beet	955	1,663	..	..	708	42·6
Cabbage	4,491	4,734	..	..	243	5·1
Rape	10,756	10,656	100	0·9	..	..
Vetches or Tares, for Seed	108	100	8	8·0	..	..
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	10,349	10,712	..	..	363	3·4
Carrots	353	350	3	0·9	..	..
Onions	142	129	13	10·1	..	..
Flax	64	72	..	..	8	11·1
Small Fruit	8,162	8,233	..	..	71	0·9
Rye-grass and other Rotation Grasses and Clover — For Hay . .	422,257	410,491	11,766	2·9	.	..
Rye-grass and other Rotation Grasses and Clover — Not for Hay .	1,112,121	1,088,777	23,344	2·1	..	..
Rye-grass and other Rotation Grasses and Clover — Total	1,534,378	1,499,268	35,110	2·3		..
Other Crops	3,287	3,007	280	9·3	..	..
Bare Fallow	6,701	5,562	1,139	20·5	..	..
Orchards (*a*)	1,061	1,004	57	5·7	..	..

LIVE STOCK.

Distribution.	1931.	1930.	Increase.		Decrease.	
	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	117,221	120,231	..	..	3,010	2·5
Unbroken Horses (including Stallions) — One year and above ..	14,479	15,075	..	..	596	4·0
Unbroken Horses (including Stallions) — Under one year ..	4,816	5,093	..	..	277	5·4
Total	136,516	140,399	..	..	3,883	2·8
Other Horses	16,152	15,917	235	1·5	..	..
Total of Horses	152,668	156,316	..	..	3,648	2·3
Cows in Milk	346,236	350,781	..	..	4,545	1·3
Cows in Calf, but not in Milk..	51,702	46,895	4,807	10·3	..	..
Heifers in Calf	56,149	55,381	768	1·4	..	..
Bulls being used for Service	17,808	17,147	661	3·9	..	..
Other Cattle :—Two years and above ..	194,019	216,762	..	..	22,743	10·5
,, ,, One year and under two ..	293,315	304,602	..	..	11,287	3·7
,, ,, Under one year	249,618	244,431	5,187	2·1	..	..
Total of Cattle (*c*)	1,208,847	1,235,999	..	..	27,152	2·2
Ewes kept for Breeding	3,414,990	3,325,234	89,756	2·7	..	..
Rams to be used for Service in 1931	94,483	92,313	2,170	2·4	..	..
Other Sheep :—One year and above . ..	982,286	969,782	12,508	1·3	..	..
,, ,, Under one year	3,339,079	3,262,272	76,807	2·4	..	..
Total of Sheep (*c*)	7,830,787	7,649,551	181,236	2·4	..	..
Sows kept for Breeding	20,425	17,900	2,525	14·1	..	..
Boars being used for Service	2,135	1,773	362	20·4	..	..
Other Pigs	139,643	123,596	16,047	13·0	..	..
Total of Pigs	162,203	143,269	18,934	13·2	..	..

(*a*) Any Crop or Grass grown in Orchards is also returned under its proper heading.
(*b*) Includes land on Deer Forests used for grazings.
(*c*) Including cattle and sheep grazed on Deer Forests.

ACREAGE under WHEAT, BARLEY (including BERE) and OATS in each COUNTY on 4th June 1931, with COMPARISON for 1930.

COUNTIES.	Wheat.		Barley (including Bere).		Oats.	
	1931.	1930.	1931.	1930.	1931.	1930.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	...	13	9,306	11,695	169,853	172,948
ANGUS	10,889	11,924	9,053	11,672	53,352	55,218
ARGYLL	1	2	609	760	14,118	14,335
AYR	710	722	17	26	33,517	36,403
BANFF	..	12	5,276	6,859	42,077	42,599
BERWICK	1,435	1,537	8,743	10,079	24,284	24,696
BUTE	...	4	7	12	4,184	4,294
CAITHNESS ...	...	...	348	403	25,175	25,704
CLACKMANNAN ...	151	213	51	51	2,514	2,659
DUMFRIES ...	46	39	42	31	31,981	33,582
DUNBARTON ...	288	323	2	5	5,614	6,127
EAST LOTHIAN ...	5,003	5,282	10,666	12,339	13,612	13,970
FIFE	10,898	11,493	8,552	9,782	37,714	40,576
INVERNESS ...	25	22	3,042	3,741	27,263	28,085
KINCARDINE ...	1,034	1,055	4,609	5,867	30,081	30,529
KINROSS	192	275	69	109	5,834	6,091
KIRKCUDBRIGHT...	41	57	44	47	18,245	19,056
LANARK	1,668	1,545	50	76	32,548	34,262
MIDLOTHIAN ...	4,631	4,855	2,974	3,173	18,013	19,250
MORAY	642	588	6,916	9,160	23,132	21,986
NAIRN	...	...	1,687	1,977	6,028	5,732
ORKNEY	...	...	2,755	2,982	29,219	29,870
PEEBLES	4	2	92	28	4,982	5,274
PERTH	6,491	7,475	1,418	1,843	57,736	61,435
RENFREW ...	1,287	1,360	26	19	7,749	8,548
ROSS & CROMARTY	568	767	4,793	5,908	31,522	30,864
ROXBURGH ...	859	950	4,720	5,552	20,903	21,415
SELKIRK	5	...	31	72	3,073	3,124
STIRLING	1,171	1,143	175	311	15,019	16,046
SUTHERLAND ...	...	...	158	194	6,381	6,600
WEST LOTHIAN ...	1,985	2,255	1,138	1,218	9,374	10,047
WIGTOWN	...	14	51	76	23,706	24,524
ZETLAND	...	...	480	504	5,884	5,863
TOTAL ...	50,024	53,927	87,900	106,571	834,687	861,712

ACREAGE under POTATOES, TURNIPS and SWEDES and SUGAR BEET in each COUNTY on 4th June 1931, with COMPARISON for 1930.

COUNTIES.	Potatoes.		Turnips and Swedes.		Sugar Beet.	
	1931.	1930.	1931.	1930.	1931.	1930.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	6,968	7,003	75,410	77,227	2	2
ANGUS	17,168	15,818	28,097	28,829	68	138
ARGYLL	2,452	2,520	4,546	4,632	...	...
AYR	7,572	7,552	6,539	6,803	...	1
BANFF	1,602	1,671	18,081	18,568	5	11
BERWICK	1,989	1,995	17,775	18,539	22	33
BUTE	908	902	1,105	1,183	...	...
CAITHNESS ...	988	1,056	9,613	9,999	...	...
CLACKMANNAN ...	304	317	670	743	...	...
DUMFRIES ...	2,732	2,544	13,593	14,144	1	...
DUNBARTON ...	1,950	1,754	1,276	1,361	...	...
EAST LOTHIAN ...	7,584	7,141	11,488	11,678	18	84
FIFE	14,959	13,908	18,611	19,408	731	1,248
INVERNESS ...	4,467	4,621	8,072	8,406	...	...
KINCARDINE ...	3,558	3,433	14,355	14,807	...	...
KINROSS	1,021	920	2,197	2,278	...	3
KIRKCUDBRIGHT	1,185	1,196	8,254	8,527	...	...
LANARK	5,502	5,055	8,967	9,116	...	...
MIDLOTHIAN ...	5,550	5,506	8,778	9,029	13	11
MORAY	1,525	1,501	12,482	12,835	17	14
NAIRN	242	232	3,579	3,609	...	...
ORKNEY	1,914	1,989	12,285	12,357	...	...
PEEBLES	260	289	2,515	2,488	...	...
PERTH	15,690	14,804	21,599	22,734	78	88
RENFREW	2,764	2,652	1,846	1,896	...	...
ROSS & CROMARTY	6,537	6,583	12,865	13,067	...	...
ROXBURGH ...	1,103	1,010	14,620	15,360	...	3
SELKIRK	115	117	1,738	1,899	...	...
STIRLING	2,970	2,660	3,231	3,511	...	...
SUTHERLAND ...	944	984	2,384	2,411	...	...
WEST LOTHIAN ...	2,235	2,207	2,986	3,092	...	...
WIGTOWN	1,429	1,507	10,758	11,179	...	27
ZETLAND	1,915	1,911	1,013	981	...	...
TOTAL	128,102	123,358	361,328	372,696	955	1,663

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1931, with COMPARISON for 1930.

COUNTIES.	Rye-grass and other Rotation Grasses and Clover.				Permanent Grass.			
	For Hay.		Not for Hay.		For Hay.		Not for Hay.	
	1931.	1930.	1931.	1930.	1931.	1930.	1931.	1930.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	54,358	51,481	251,199	247,958	1,276	2,412	49,092	47,489
ANGUS	24,448	24,002	65,146	60,851	1,719	1,969	30,509	30,149
ARGYLL	12,274	11,946	15,497	15,511	14,616	15,560	50,257	49,817
AYR	27,575	26,991	47,260	46,243	21,858	22,424	157,589	155,933
BANFF	10,979	10,039	63,145	61,649	506	559	13,739	13,896
BERWICK ...	12,829	11,963	51,460	50,839	2,957	2,348	64,744	64,328
BUTE	2,378	2,416	5,558	5,698	520	460	10,808	10,326
CAITHNESS ...	9,655	9,671	32,158	31,701	839	585	24,450	24,232
CLACKMANNAN	1,219	1,337	1,477	1,281	1,355	1,296	6,850	6,809
DUMFRIES ...	20,290	20,714	47,430	46,202	19,160	19,150	105,054	104,305
DUNBARTON ...	5,327	5,328	4,511	4,469	2,058	2,288	23,175	22,759
EAST LOTHIAN	9,520	9,443	18,533	17,494	1,165	1,479	27,348	26,338
FIFE	27,123	26,769	31,245	29,390	4,748	4,894	79,448	76,633
INVERNESS ...	12,178	12,190	23,247	22,908	9,492	9,699	57,561	57,335
KINCARDINE ...	13,149	12,641	37,090	35,684	379	458	11,851	11,910
KINROSS ...	3,052	2,840	6,697	6,625	851	726	11,825	11,956
KIRKCUDBRIGHT	11,061	10,964	38,223	40,329	12,141	13,053	88,865	85,797
LANARK ...	30,905	30,438	33,131	31,986	13,598	14,136	107,517	107,443
MIDLOTHIAN ...	11,169	10,765	16,955	17,173	2,466	2,144	42,958	42,354
MORAY	6,639	5,889	35,489	35,475	259	483	8,358	7,959
NAIRN	1,793	1,840	9,063	9,060	84	92	2,543	2,400
ORKNEY ...	10,937	11,094	33,974	32,699	796	1,224	15,542	15,249
PEEBLES ..	2,665	2,469	9,470	9,436	1,428	1,289	29,015	29,076
PERTH	34,011	32,950	61,886	59,795	11,839	11,958	100,489	99,624
RENFREW ...	8,152	8,122	6,379	5,891	6,021	7,189	44,022	43,075
ROSS AND CROMARTY ...	13,298	13,021	35,311	36,049	4,237	3,927	27,103	26,569
ROXBURGH ...	10,911	10,425	51,741	49,015	7,073	7,782	60,513	61,352
SELKIRK ...	1,449	1,713	6,795	6,408	2,191	1,930	14,416	14,570
STIRLING ...	10,542	10,364	10,264	9,547	8,958	8,356	54,777	55,351
SUTHERLAND ...	4,596	4,456	5,944	5,702	1,614	1,504	8,463	8,819
WEST LOTHIAN	6,798	6,724	4,741	4,370	1,293	997	22,314	22,340
WIGTOWN ...	9,308	7,909	50,483	50,808	6,082	6,265	51,070	50,814
ZETLAND ...	1,674	1,577	619	531	2,114	2,074	12,362	11,186
TOTAL ...	422,257	410,491	1,112,121	1,088,777	165,643	170,710	1,414,627	1,398,193

NUMBER of HORSES, CATTLE, SHEEP and PIGS in each COUNTY on 4th June 1931, with COMPARISON for 1930.

COUNTIES.	Horses.*		Cattle.†		Sheep.†		Pigs.	
	1931.	1930.	1931.	1930.	1931.	1930.	1931.	1930.
	No.	No.	No.	No.	No.	No.	No.	No.
†ABERDEEN ..	21,635	22,279	170,732	183,926	411,076	377,920	19,953	18,808
†ANGUS	7,191	7,848	49,125	52,972	217,787	209,893	8,366	6,947
†ARGYLL ...	4,169	4,299	49,901	50,981	714,725	711,218	3,867	3,312
AYR	6,939	7,061	112,245	109,886	410,183	394,804	10,769	8,822
†BANFF . ..	6,423	6,616	42,505	43,691	114,716	103,066	6,250	5,406
BERWICK ...	3,152	3,614	24,945	27,580	411,640	394,667	4,315	3,678
BUTE	939	948	9,128	9,096	42,689	42,470	599	511
†CAITHNESS .	4,265	4,383	18,790	19,796	189,817	195,638	1,609	1,615
CLACKMANNAN	457	478	4,016	3,939	13,603	13,459	465	283
DUMFRIES ..	5,206	5,280	70,857	68,447	580,919	573,032	8,982	8,114
†DUNBARTON ..	1,210	1,215	13,424	12,892	70,444	68,838	1,272	944
EAST LOTHIAN	2,765	2,837	15,017	17,043	173,019	166,300	3,071	2,974
FIFE ..	6,712	6,949	46,139	47,931	161,919	147,274	8,639	6,235
†INVERNESS ...	5,750	6,289	42,716	45,311	503,941	505,748	1,980	1,755
†KINCARDINE ...	3,583	3,709	26,961	28,699	80,851	71,889	3,198	2,807
KINROSS .	824	847	6,252	6,131	37,059	36,900	785	548
†KIRKCUDBRIGHT	3,476	3,579	58,576	58,126	400,761	391,230	11,042	10,760
LANARK .	5,729	5,751	72,139	69,990	240,394	240,573	7,135	5,920
MIDLOTHIAN .	2,693	2,766	18,301	18,989	200,891	192,114	12,988	13,062
MORAY .	3,639	3,758	23,492	24,820	56,797	51,336	4,905	4,258
NAIRN .	981	1,051	6,633	7,041	16,951	14,572	720	658
ORKNEY .	5,474	5,419	36,594	36,081	68,680	63,869	1,936	2,002
PEEBLES	701	699	7,058	7,191	207,547	211,844	929	760
†PERTH ..	9,031	9,356	67,754	70,446	661,517	657,211	8,386	8,096
RENFREW .	1,914	1,946	24,425	24,216	47,631	43,654	3,945	3,260
†ROSS AND CROMARTY	5,387	5,542	36,857	37,448	330,339	323,913	3,538	3,181
ROXBURGH ..	3,007	3,106	25,438	26,063	585,720	587,054	3,043	2,945
SELKIRK .	477	496	4,013	3,964	187,123	193,169	385	344
STIRLING ..	3,098	3,133	33,236	32,517	130,053	122,175	2,799	2,064
†SUTHERLAND ...	1,697	1,733	8,611	8,642	214,243	218,977	417	468
WEST LOTHIAN	1,614	1,684	12,605	12,527	27,153	24,699	2,824	1,533
WIGTOWN ..	4,185	4,276	59,789	58,912	152,050	139,579	13,398	11,582
ZETLAND .	1,893	1,952	10,573	10,672	168,549	160,876	198	167
TOTAL ...	136,516	140,399	1,208,847	1,235,999	7,830,787	7,649,551	162,203	143,269

* Horses used for agricultural purposes, mares for breeding, and unbroken horses (including Stallions). "Other Horses" on agricultural holdings are not included; the total for these in Scotland is given in the summary table on p. 118.

† Including cattle and sheep grazed on Deer Forests.

DEPARTMENT OF AGRICULTURE FOR SCOTLAND,
EDINBURGH, 18th *December* 1931.

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THE AGRICULTURAL CRISIS.

JOSEPH F. DUNCAN,

Secretary, Scottish Farm Servants' Union.

"The fundamental causes of the crisis should be considered in the light of the general economic conditions of the world."

THAT sentence from the Report of the Economic Committee of the League of Nations on "The Agricultural Crisis" [1] is a much needed reminder to those interested in agricultural problems that agriculture is not a self-contained department of human activity, and a reading of the Report, which contains surveys of the position of the agricultural industry in all the principal countries of the world, and the measures taken to meet the depression, reinforces the need for that reminder. In most countries the problem has been discussed as if political action on national lines were all that is necessary to avert the worst effects of the depression, and sufficient attention has not been paid to the economic forces at work which refuse to be confined within national borders. To quote the Report again :—"As the essential reasons of the agricultural crisis in the various countries are to all appearances of a universal character, the possibilities of coping with the crisis in a particular country are very limited."

I do not propose to discuss the immediate causes of the acute depression through which agriculture everywhere in the world is passing, and which has affected agriculture less seriously in this country than in most. What I propose to consider are some of the long trend tendencies which are at work and which are more fundamental in their effect on agriculture in the long run, and which will continue in operation after the dislocations due to the war and the financial repercussions of the post-war period have spent themselves. These dislocations have forced the pace of change in some directions, and in others slowed it down, but have brought into clearer relief the developments which were in progress before the war.

The war hastened the closing of the epoch of colonial development. It was upon that development that the expansion of the

[1] League of Nations. Geneva, 1931. Price 7*s*. 6*d*.

industry of Europe, and latterly of the United States, depended, and that of Great Britain most of all. The settlement of the lands overseas provided an outlet from the products of the growing industrial plants, particularly those producing constructive material such as railways, bridges and machinery, while the stream of emigrants from Europe to settle the new lands relieved the Old World of rapidly growing populations. The New World was being called in to redress the balance of the Old. It was a profitable procedure for the Old World and, particularly, for Great Britain. The new settlers raped virgin lands and sent cheap food to Europe, and where lands were not suitable for white settlers, native populations, at a very low standard of living, exchanged the products of their labour on terms favourable to the industrialists.

But if the colonial system gave an enormous development to the industrial system, its effect on European agriculture was not so happy. Cereal growing over large areas became unprofitable and had to be abandoned. In Great Britain it shrank to small proportions. During the whole period there were not wanting those who deplored the sacrifice of the agricultural industry, but it is doubtful, to say the least, whether some forty millions of people could have been maintained on this island, at the standard of living which has been possible, if it had not been for the exceedingly favourable terms on which we were enabled to draw our food supplies from overseas. And it should not be forgotten that without the outlet for emigration to the new lands, the pressure of population in the rural areas would have kept the standard of living lower than it was. That standard has always compared unfavourably with that of the industrial population, but has always been the highest in Europe because we have had easier outlets for the surplus population overseas, and a greater demand from the more rapidly developing industrial areas at home.

It would not be true to say that we have come to the end of the colonial development. During the past two years the doors have been closed against our emigrants in those countries to which they were accustomed to go. Indeed the returning stream has been nearly as great as the outward flow recently, but as the fury of the economic blizzard dies down, we may reasonably expect some of these doors to be opened again, although never thrown so wide as they used to be. In some areas the limits of expansion have been reached, but of even more importance to agriculture is the emergence of new technical methods which call for less labour in the exploitation of new lands. The old settler was attracted by the offer of cheap land. All the capital he required was the price of a horse team and the implements necessary to plough, sow and reap a crop of wheat after he had cleared his land. Provincial Governments, railway companies and land speculators vied with each other in offering attractive terms to prospective settlers. Even those without capital found it possible after a year or two as hired men

on farms to amass sufficient to enable them to take up farming on their own. If the venture did not always turn out as they had hoped, there were always plenty of others to step into their shoes if they quitted.

That day is ended. The development of mechanised grain growing is going to render it exceedingly difficult for the established farmers, who cannot change over to the new method, to hold their own against the competition of those producing grain on the lower scale of costs made possible by the new mechanical methods. The pioneer settler without the capital necessary to set up on the new method stands no chance at all. The conclusion reached by the Imperial Economic Committee as stated in the Report [1] recently issued after a study of the situation created by the new technical methods, sums up as follows :—

> " Our conclusion on the facts set out in this section is that in the absence of some unexpected influence they establish the expectation over a long period of years of a continuous struggle—possibly a protracted and painful struggle—between those farmers who by adopting new technique or otherwise are able to reduce costs and those who fail to do so. Such a struggle implies a low level of prices. It implies also a continuation of the progressive decrease in the numbers employed in wheat production as labour-saving machinery is adopted. It would be hard to exaggerate the significance of these developments."

Thirty-two years ago Sir William Crookes issued a warning to the world of the coming shortage of wheat owing to the exhaustion of the wheat lands, and during the war Lord Rhondda, while Food Controller, thought it worth while to reissue that warning. With these examples in front of us it is safer not to prophesy too far ahead, but with Russia threatening to enter the market on an even larger scale than it did before the war, it seems fairly safe to forecast that in our day we are not likely to see any further development of extensive land settlement in areas suitable for white settlers, which would provide the continuous expansion of markets for industrial products, and an outlet for the surplus population from the agricultural districts of Europe. It is important to remember, also, that the United States of America, which was a debtor country prior to the war, is now the principal creditor country of the world, and instead of providing a market for the industrial products of Europe, is competing with Europe in the debtor countries, with resources based on a home market of 120 millions of population, with all the advantages of large scale production which such a market gives. Since the tendency during the whole of the industrial era has been for productive capacity to outpace the growth of markets, and the productive power of industry has increased enormously in the last two decades, the slackening of the pace in the development of new lands is bound to bring far

[1] " The Wheat Situation, 1931." H.M.S.O. Price 6*d.*

reaching changes. It is worth while trying to estimate the effect on agriculture.

It may seem that I am giving too much attention to the changes in the industrial situation, but that can only be the view of those who forget that the exchange of agricultural products for manufactures is one of the fundamental exchanges. Agriculture is not only interested in the development of industry because it is amongst industrial workers that it has to find consumers, and its prosperity is dependent upon their power to purchase its products; it is as much concerned in its marketing strength compared with that of industry, because upon that depend the terms upon which the exchanges are to be effected. The effect of industrial depression on agricultural prices is obvious, but what is not so generally realised is the effect of industrial and commercial developments on the relative marketing strength of agriculture. All modern developments have tended towards the weakening of the position of agriculture in the market. The development of transport and communications, the improvement in methods of preserving and storing foodstuffs, and the organisation of retail distribution by multiple traders, both co-operative and joint stock, have all had the effect of placing the market further out of reach of the producer and beyond his power to influence effectively. The multitude of farmers renders control of production out of the question. In some parts of the world farmers have been alive to this difficulty, or have been compelled to organise their marketing to reach a distant market, but, as a whole, farmers until quite recently have not attempted to meet the changed conditions.

It is otherwise with industry. The drive has all been in the direction of consolidating productive forces and regulating marketing so as to secure the largest possible measure of marketing strength. We can see that the present depression has very considerably increased this tendency, and has even added to the number of our "blessed words" that of Rationalisation. In retail distribution the policy has rapidly extended in the last decade. The result shows itself in the disparity between the fall in retail prices, wholesale prices of manufactures and prices of primary products, including agriculture. The rate of fall is in descending order from retail prices to prices of raw materials. What is new is not that prices of agricultural products fall more rapidly than manufacturers' prices or retail prices, but that the disparity between these prices appears to be increasing. Agriculture has always been weak in a falling market because production must go on; it may be slowed down but it cannot be shut down except after a long interval. Industry can shut down production, and can do so more effectively if large mergers control a considerable extent of the output, and thus save itself from a flooded market. Agriculture can do so only involuntarily and over a considerable period and must shoulder the loss in the meantime. It seems a reasonable deduction that the changes in industry and commerce,

particularly in the last decade, have strengthened the position of industry as against agriculture.

For the last fifty years the scales have been tipped against agriculture. The returns to capital and the earnings of wage-earners have been lower than in other industries. It was estimated before the war that the share of the national income accruing to agriculture in the United States of America was 18 per cent., although one-third of all the people engaged in money-earning occupations worked in agriculture and one-quarter of the total national capital was employed there. The figures given in the last Census of Production show that the output per head of those employed in this country was the lowest in agriculture. Figures for rates of wages between workers in agriculture and for those in industry are not a reliable index of earnings, but when every allowance is made, it is true to say that wages in agriculture are distinctly lower than wages in industry and commerce in every country. More significant is the statement of the Chief of the Agricultural Service of the International Labour Office [1] :—" There is a gap, often a huge gap, between agricultural and industrial wages, and the effects of the crisis show themselves in the tendency for that gap to widen."

I would sum up the trend of economic forces at work in the world, within which agriculture has to adjust itself, as follows. It would appear that the rate of industrial expansion upon which this country has depended for the past two generations will slow down very considerably and new forms of industrial activity will have to be sought. That is likely to lead to a very considerable restriction in the opportunities for the surplus population reared in agricultural families finding employment in industry. At the same time, the opportunities for emigration are unlikely to provide anything like the outlet we have been accustomed to. This is showing itself in the number of unemployed agricultural workers *remaining* in rural Scotland. The number of *disemployed* farm workers is probably not as great as it has been in former years (the decrease between 1908 and 1913 of male workers regularly employed on Scots farms according to the Agricultural Returns was 17,400 and between 1921 and 1931 was 6,441), but the new feature is that the workers have to remain unemployed because they cannot find openings in other industries and emigration has virtually ceased. The position is worse in nearly all European countries, while in overseas countries the agricultural populations have now begun to decline. Against this has to be set a decline in the birth-rate in most countries, although the rate of decrease amongst the agricultural population is not so great as amongst the urban population.

Turning to agriculture itself we find a rapid increase in its productive powers. The results of a generation of scientific research and education are beginning to be applied, and if the rate of progress is slow compared with the knowledge available,

[1] *International Labour Review.* Matthaei. April 1931.

it is more rapid than our power to put the output into consumption. The engineers have only begun to apply themselves seriously to the development of agricultural machinery, but have already produced revolutionary changes in cereal growing. All this points to the likelihood that production will continue to increase with a decreasing employment of labour. The rate of change will be much slower in agriculture because so much land is in the possession of small peasants who are more resistant to change and who will rather continue in the industry at a lower standard of existence than go out, because they have nowhere to go. But even the peasant outlook is changing with the breaking down of the barriers between rural and urban workers, the growth of communications and, above all, the spread of education.

In the long run there is nothing to cavil at in these changes. They are what we have laboured for a generation to bring about. In every country large sums have been expended to find methods of increasing agricultural output and to save labour. We still continue to search for even better methods, and will continue to do so most earnestly just when we are finding it most difficult to market what we have produced. The situation will not be remedied by slowing down improvements in production. The more we can produce with less labour the greater are the possibilities of improving the standard of living of those engaged in the industry, and that ought to be the first concern for those engaged in agriculture. The wider problem of how to adjust production and consumption both in industry and in agriculture is a problem for the community as a whole and one in which those engaged in agriculture ought to take their part as citizens, but the domestic duty of attending first to their own affairs is one they cannot leave to others.

The problem is not, as is often stated, how to find more employment in agriculture. The fact is that we have too many people employed in agriculture now, as is shown by the low returns to those engaged in it. Merely to increase the numbers employed without increasing the economic output would result in a lowering of the standard of living of those engaged in it. We do not ask that any other industry should increase the numbers employed. All our efforts are concentrated on increasing the economic output. We ask for efficiency, and our test of efficiency is not the numbers employed, but the return for the capital employed and the ability of the industry to pay reasonable rates of wages and observe reasonable conditions of labour. It is only in agriculture that we apply the test of numbers and neglect the economic tests we apply to other industries, and those engaged in agriculture suffer in consequence. Until we apply the same economic tests to agriculture as we do to other industries we shall never face the real problem, and that is how to secure for those engaged in agriculture conditions equivalent to those engaged in other industries. I use the word equivalent advisedly and not the word equal, because there are other satisfactions which

enter into the equation than the rate of return on capital employed and rate of wages to the workers. Agriculture as a way of living provides certain satisfactions which industrial life does not give to certain persons and these have to be allowed for, but when every allowance has been made, there is still a considerable gap to be bridged to bring those engaged in the industry to the position they have a right to claim.

We must be as ready to face alterations in the structure of agriculture as we are in other industries. There is no reason to suppose that the small one-man business must continue to be the unit of production in farming any more than in other industries. If it can prove itself better fitted to survive, it will survive, but there is no more social value in the one-man business in agriculture than in weaving, milling, mining or engineering. There may be a sentimental value in all industries in preserving the small business, but that has not prevented industry from working steadily towards the larger unit. The tendency has been to impose on agriculture the sentimental view and to subsidise the smaller units. Here again the sanction sought is not the economic one. It is merely one instance of the unwillingness to apply to agriculture the economic principles we apply to other industries, and our unwillingness to consider the desirability or necessity of departing from the traditional structure of the industry. The result is that we have all kinds of proposals put forward for reconstruction of the industry, but no adequate investigation has been made to enable us to judge of the value of these proposals. It is difficult even to secure any dispassionate consideration of any reconstruction proposals, so strong is the prejudice against any change in tradition. Until there is greater willingness to face the problems of the industry in a less prejudiced spirit, there is little hope of progress. There is no reason to believe that the form farming took in the middle of the nineteenth century is necessarily right for the middle of the twentieth.

In one direction it is clear that the structure of the industry must change. The independent farm run by one man who manages production and marketing, independently of his fellows engaged in the same business, cannot survive. The market is no longer a local market with which the farmer can keep himself acquainted. Farmers themselves have recognised this and attempts have been made to work out new methods of marketing. It is clear now that marketing of agricultural produce under modern conditions is a specialised business, and if farmers are to retain any control over the marketing of their produce they must organise their own marketing agencies. It is the only way in which they can increase the marketing strength of the industry and give them the possibility of exchanging their products against the products of industry on something like equal terms. But as these marketing agencies develop they will cut off from the one-man farm a considerable amount of the justification for the heavy overhead charges which such a unit involves. Already

the tendency is well under way for the more enterprising farmers, who can secure sufficient capital, to take on more than one farm. They find they have not sufficient scope for management or a sufficient return on one farm. The probability is that we shall see a still further development of the multiple-farmer on the one hand and of the working farmer on the smaller farm on the other, and the typical farm managed by one man as we know it to-day will tend to disappear.

The signs are that considerable changes will be forced upon the industry. Whatever expedients are adopted to tide over the immediate depression, the economic forces at work will continue to force changes. The passing out of wheat from the farm to the factory, and the decrease in the consumption of oats and malting barley, are likely to be permanent changes which must modify farming systems everywhere. Farmers in the more settled districts overseas, and in Europe, will be forced over in increasing numbers to other farm products, thus intensifying the competition in the marketing of milk and dairy products, vegetables, and pig and poultry products.

It is in the development of the production of these products that the future of European agriculture is likely to lie. While the consumption of bread stuffs in the last decade appears to be falling behind the increase in the population, we have to remember that it has been a decade during which large sections of the people of Europe have been living under abnormal conditions and unable to purchase their normal requirements, and consumption may increase. It appears, however, from the experience of this country and of North America that a rise in the standard of living leads to a fall in the consumption of cereals, and an increase in the animal, vegetable and fruit products. If the demand for wheat is relatively inelastic, that is not true of the constituents of a more varied diet. We are not likely to reach the consumption limits there for a considerable time, if the purchasing power of the consumers were equal to their appetite.

Here we find the Achilles heel of the economic problem of to-day. We have mastered the problem of production both in industry and agriculture. We no longer need go in fear of scarcity. We have still to reckon with crop failures as local problems, but the probability of a world shortage of food is very remote. We are much more worried by surpluses to-day than by shortages, and as time goes on the problems of distribution are likely to be more engrossing and productive problems less likely to worry us. And the problems of distribution are problems of human organisation and, properly considered, ought to be much easier of solution than the problems of production which occupied our fathers and baffled our grandfathers.

The bearing of this on agriculture is that the possibilities of development depend on a progressive improvement in the standard of living. We shall have to rely more on the intensive cultivation of existing markets rather than on the discovery of

new markets by extending the settled areas of new lands. Industry will have to find new outlets by supplying the needs of existing communities with new goods and services. We are seeing this development going on in this country to-day. What are called the luxury trades have been extending, while the basic trades of nineteenth century development have not been expanding. As is usual in a time of change, the moralists are inclined to shake their heads dolefully, but it is well to remember that what are reckoned luxuries in one generation often become necessaries in the succeeding one, and a Georgian picture house is after all an improvement on a Victorian public house. And if bacon and eggs is what people prefer for breakfast, it is the farmer's business to supply that and not try to convince them that they ought to stick to porridge.

What is important for agriculture is that those engaged in it should secure their share in any improvement in the standard of living. That depends in the long run on the power of the industry to increase its economic output and to strengthen its exchange position in relation to industry. For agriculture in a country such as Britain with a relatively small agricultural population and a large market at its doors, the industry will find its most profitable outlet in the production of quality goods in which its advantage of being able to supply fresh products in their natural state can be most fully exploited, but success in that direction will require intensive study of consumers' demands and a marketing system that will ensure efficient grading and, through that, direct efficient production. Haphazard methods of production and unorganised marketing will never reach the modern consumer nor lead to the necessary development of the industry.

An improvement in the standard of living of those engaged in agriculture will be necessary also to balance industrial production. While it is true that there is a large potential demand for agricultural products of a quality standard which can become an effective demand with a rising standard of living, it is equally true that there is a large potential demand for goods and services which industry could supply to the agricultural population. Much of what has become the normal standards of housing equipment in urban areas is practically unknown amongst the mass of those engaged in agriculture. For most of those employed in agriculture the standard of living has often barely reached the mere existence level and seldom risen above it. A better balance between returns to agriculture and industry would open up a large market for industry and do much to prevent the recurrence of trade crises.

DEVELOPMENT OF HORTICULTURE IN SCOTLAND.

DUDLEY V HOWELLS, Agri. Dip. (U.C.W.).

Introduction.—The Customs Duties on Horticultural Produce open up a wide field of possibilities to growers adopting intensive cropping methods and should greatly encourage the cultivation of crops grown under glass or forced by other methods. Undoubtedly the operation of the "Emergency" duties is presently more in favour of growers in the South of England and the Channel Islands than those in Scotland, but the effect on supplies and the consequent greater demand for the English products at home must make a difference to the Scottish home markets. In a general survey of the duties imposed it is at once evident that special importance attaches to that on tomatoes. The tomato is easily the most important glasshouse crop in Scotland, and the protection afforded by the duties imposed has already had its repercussion in an extension of the industry. Particulars of the horticultural Customs duties are given elsewhere.

All imported horticultural products will now be subject to a tax of 10 per cent. under the Import Duties Act. It is apparent that those articles subject to the Emergency Customs Duties will come under the General Import Duties when the former cease to operate.

It is not possible to obtain reliable statistics of the imports of foreign horticultural produce into Scotland, because in addition to that which is definitely landed at our home ports a considerable amount filters in from Newcastle, Hull, Grimsby, Liverpool, &c.

The latest published statistics of horticultural imports contain the following items :—

Apples	£7,882,131
Currants	227,109
Gooseberries	11,771
Grapes	1,887,732
Plums	920,764
Strawberries	217,878
Tomatoes	4,566,096
Vegetables	1,691,077
Flowers	1,064,893

Comparison between imports and the amount produced at home (estimated) :—

	Home.	*Imported.*
Gooseberries ...	43,350 tons.	6,130 tons.
Currants	21,925 ,,	3,384 ,,
Cauliflower and Broccoli	16,200 ,,	18,370 ,,
Carrots	111,000 ,,	18,450 ,,
Green peas ...	72,700 ,,	2,628 ,,
Tomatoes	52,500 ,,	152,600 ,,
Cucumbers ...	50,000,000 (No.)	2,744 ,,
Salads		12,500 ,,

The estimated value of all the home glasshouse produce is :—

	Home.	*Imported.*
Tomatoes	£2,350,000	£4,566,096
Cucumbers	750,000	
Grapes	130,000	1,887,732
Chrysanthemums ...	200,000	
Carnations	85,000	
Roses	250,000	
Flowers (total)	1,750,000	1,064,893

If British growers are prepared to avail themselves of the opportunity presented by an impeded foreign competition it is essential that they utilise every device possible for producing earlier and heavier crops. The amount of fiscal favour which will be shown to them in the future must be dependent on the manner in which they seize their present opportunity. The need for extra supplies must be met by increased home production.

Some idea of the extent to which intensive cultivation has been developed in Holland and Belgium may be obtained from the following :—

A. *Holland.*—Acreage of horticultural crops in Holland, 1912 and 1927 :—

	1912.[1]	*1927.*[2]
	acres.	acres.
Early potatoes	14,735	19,133
Strawberries	2,710	5,840
Orchards	61,075	78,038
Currants	5,750	5,475
Grapes (Hothouses)	168	978
Vegetables	56,083	78,958
Vegetables and fruits (Hothouses)	475	2,505
Hotbeds	1,193	2,083

At Aalsmeer, the centre of flower growing, the area under glass extended in 1931 to 225 acres, all of which had been erected within 28 years. The most important crop is roses, of which 60 million blooms were sold in 1929, and in that year £85,000 was spent on the erection of houses for rose forcing. The other plants forced include hydrangeas, cyclamen, lorraine begonias, pelargoniums, azaleas, spiræas and ferns among pot plants; lilacs, flowering cherries, bulbs, sweet peas and chrysanthemums as cut flowers. The total value of the produce was £544,000.

The reports of co-operative auctions give the following details :—

Lily of the valley	2,000,000 (crowns).
Pot plants (miscellaneous) ...	1,000,000
Cyclamen	93,000
Begonias, azaleas, ferns	1,000,000
Primula obconica	133,000

Prunus triloba, bulbs, asparagus fern, dahlias and sweet peas to the value of £42,000 were marketed.

[1] Returns of Department of Agriculture. [2] Returns of Co-operative Auctions.

Westland, Holland's centre of tomato and vegetable forcing, is a veritable sea of glass. There are between 3,500 and 4,000 acres of greenhouses and 2,000 acres of frames devoted to the cultivation of tomatoes, vines, melons and salads. The expansion there since 1920 has been phenomenal.

B. *Belgium.*—At Hoeyleart, the centre of the grape industry in Belgium, there are over 750 acres devoted to grapes alone.

From Belgium we imported in the year 1930 horticultural products to the value of about 3¼ million pounds :—

	£
Chicory	69,000
Cherries	203,500
Melons	1,187
Peaches	38,500
Pears	430,197
Grapes	1,950,500
Plums	67,000
Bulbs	8,025
Greenhouse plants	390,000
Hardy plants	49,000
Cut flowers	11,000
	£3,217,909

Practically all this produce could easily be grown at home.

Systems of Intensive Cultivation.—*The French Garden.*—A very intensive system of market gardening is carried on by French growers in the neighbourhood of Paris and elsewhere. As many as six crops are raised in a year from the same piece of ground. These crops have been marketed in Great Britain at a time when there is little or no home produce to compete with them. It has been estimated that the gross returns per acre are as high as £700 per year.

These results are due to the intensive methods employed rather than to the natural climatic and soil conditions. So far as climate is concerned, most parts of Britain have a more equable temperature than the market gardening districts of France; and such large quantities of manure and other organic materials are used that the original soil does not count for much. The chief necessities are—site, shelter, clear and not too humid atmosphere, well-drained soil, copious supplies of stable manure, both for heat and soil enrichment, and a good water supply.

For forcing the crops, frames and some form of movable glass covers are essential. The frames consist of a large number of movable sashes 6ft. × 4ft., placed side by side in continuous rows and supported top and bottom on thick planks set upright 15 inches at the back and 9 inches in the front. The cloche is mostly used for covering crops planted out.

The chief source of heat is the fermenting stable manure termed the hot-bed. For this purpose and also to improve the

soil huge quantities were formerly used, as much as 1,000 tons per acre being used annually during the first three years. This is not possible to-day and substitutes have to be found. In Scotland the system would need considerable modification.

The suggestion is that existing establishments with greenhouses in which the seedlings can be forwarded should gradually be adapted for this form of cultivation. The plants can be protected in numerous ways—glass, "Ray pas," and mats being used for this purpose.

Heat may be supplied by the hot-bed, by hot-water pipes, and by buried electric cables. The last-mentioned system has been used for years in Norway, but the high charges for electricity in this country at present preclude its use. There are indications that some of the more progressive companies are willing to experiment in this matter, and probably a supply at ½*d*. per unit would be of advantage to both consumer and supplier, the latter especially, as it is a night load which is required.

Where tomato houses already exist, the spaces at both sides might quite easily be utilised for frame accommodation. Where space is limited, a brick structure, 4-5 ft. wide, heated by means of an off-set of 2 in. pipe from the existing installation, and passing along the front of the frame, is possible, where the greenhouse pipes run within 2 ft. of the soil. This off-set may be "taken off" the flow at the top end of the house and passed into the return at the other end. If the sashes are arranged to open by lifting in a "cradle" it will be more convenient than if they have to be drawn down to obtain access to the frames.

As substitutes for the original cloche system, advantage may be taken of the Chase Continuous Cloche, in which sheets of glass are supported by wires.

Another method is to use the waxed cloth known as "Ray pas." This material is somewhat cheaper than glass and can be made up in longer lengths. It requires to be nailed to a wooden framework. It can easily be made into triangular cloches resembling span-roofed greenhouses and has the advantage of completely confining the air. When made in lengths of 5 ft. 3 ins. - 6 ft. 6 ins., a series can easily be made to "nest" for storage.

Rye mats are much dearer than formerly and the quality is much poorer. Two thicknesses of hessian canvas or even waterproofed canvas may be used instead.

Possibilities of Expansion.—On considering the list of duties and the times of operation it will be seen that possibilities of expansion occur in the following crops :—Currants (black), grapes, dwarf beans, forced cauliflowers, carrots, lettuce, endive, chicory, cucumbers, mushrooms, new potatoes, flowers, foliage plants, rose trees, and tomatoes.

With the exception of currants, new potatoes, and rose trees, the whole of the possibilities lie in the use of glass houses, frames,

or some other means of forcing. In some favoured districts in Wigtownshire and Ayrshire early crops of broccoli, lettuce, endive, and carrots might be raised out of doors.

Black Currants.—Hitherto the Scottish market has been flooded by the importations of early French Blacks, which satisfied the housewife's demand before the home product was available, while a very large amount of the Norfolk crop was also sent to Scotland. With the tax of 2*d*. per lb., it may reasonably be expected that a greater amount of the English crop will find a market nearer home, and that the jam makers will purchase a far greater quantity of local-grown currants. It takes at least five years for a plantation to produce a marketable crop, but there is every indication from the increased sale of bushes this year that the area under this crop is expanding in Scotland. It would easily be possible within four years to meet all Scottish needs within the area. Incidentally there has been a considerable reduction in the area of black currants in England and Wales included in the reduction in the total area of small fruits (4,200 acres).

Grapes.—Owing to the impossibility of competing with imported grapes from Belgium, many commercial growers gave up the cultivation of grapes and turned the houses over to tomato growing. Provided the duties are maintained, an inducement for the extension of grape growing is now offered.

French Beans.—In Scotland these are almost exclusively a forced crop. They make a very good companion crop in span-roofed houses devoted to peaches and grapes, or they may precede cucumbers. The seed is sown in pots, boxes, or preferably in the border, which offers the easiest method of producing the crop. The seed should be sown 3 ins. to 4 ins. apart in a well worked soil to which plenty of organic matter has been applied. The plants require plenty of moisture, thorough drainage, and frequent syringing. The seed may be sown at intervals from the third week in January to the middle of March, and the crop takes from eight to ten weeks to mature.

While there is not a sufficient demand to warrant a large quantity being grown in pots, many borders presently uncropped might profitably be used for this crop.

The usual varieties are Williams' Earliest of All, Osborne's Forcing, Canadian Wonder, and Ne Plus Ultra.

Cauliflowers.—To benefit by the duties imposed, growers must be prepared to force cauliflowers by wintering in frames.

The seed should be sown in a cold frame in September and provision should be made for shading at midday if necessary. The soil should be fine and rich, but it is a disadvantage to add fresh organic matter for this purpose. Sow the seed thinly about September 15th and cover lightly with compost. Water thoroughly and afterwards keep fairly moist with repeated small doses rather than by large applications. As soon as germination takes place allow the surface of the soil to dry, thus reducing the risk of " damping-off."

As soon as the plants are fit to handle they should be transferred to a cold frame and set out 3″ × 3″.

The soil should be fairly good, and it is usually advisable to ensure this by adding two or three inches of rich compost. If the soil is sufficiently moist it ought not to be watered, as damp is more injurious than cold.

The plants must be kept well ventilated and covered with mats during exceptionally cold weather, and care must be taken to see that they do not get leggy during their period in the frames. To prevent this it may be necessary to give them an additional shift to 4″ × 4″ apart. Transplant in February to cold frames or to the outside under cloches, allowing 15″ - 18″ between the plants. The second batch of seed is sown in mid-October and pricked-off late in November for planting-out in the open in spring. As serious losses often occur amongst the plants wintered in frames, it is usually advisable to sow another batch in the greenhouse, late in January or early in February, and prick-out into a protected or heated frame to harden them off for planting outside in sheltered quarters.

The main varieties are Early Snowball, Erfurt, All the Year Round.

Lettuce.—This crop is in fairly constant demand from Christmas onwards, and in districts in England which specialise in this trade three sowings for early supplies are made :—

1. Towards the end of August for use at Christmas.
2. About the middle of October for the middle to the end of March.
3. Early in December for the middle of May supplies.

For the first crop the seed is sown thinly on a fine seedbed out of doors. Early in October the seedlings are transferred to their permanent quarters after the third or fourth leaf has developed, being planted 12″ × 6-7 inches with a dibber. Lettuce is a very suitable crop to plant in a tomato house which has been cleared early. Remove the tomato debris, wash down the houses with a cresol spray, and dig deeply. After the tomato crop it will be imperative to water thoroughly before digging, but no actual watering afterwards should be necessary, though an occasional spray overhead is beneficial. It is not advisable to keep heat on, but plenty of ventilation should be given. The soil needs repeated hoeing. The other sowings are made either in a frame or in a heated greenhouse. The seedlings, which must be kept cool, are transferred to a specially prepared bed, being set out 2″ to 3″ apart and later transferred to their permanent quarters. The three sowings can be used in houses devoted to tomato growing. The plants should be set out in rows 8 inches apart, leaving every third row unplanted to allow of setting out the tomatoes. In the last two plantings—January and February—it is an advantage to string the houses beforehand, and where lettuce growing is a routine operation, it would be advisable to have wires for fixing the string at the ground level. The latest

crop—that which matures about the middle of May—should be planted out in cold frames, which may be matted at night. It is very difficult to get lettuces to heart in winter, and since the Scottish consumer demands a firm lettuce it is questionable whether winter grown lettuces would be profitable.

The principal varieties are Loos Tennis Ball, Rosy Spring, May Queen, Early French Forcing, McHattie's Giant. Lettuce does not head well if the conditions are too hot and often runs to seed.

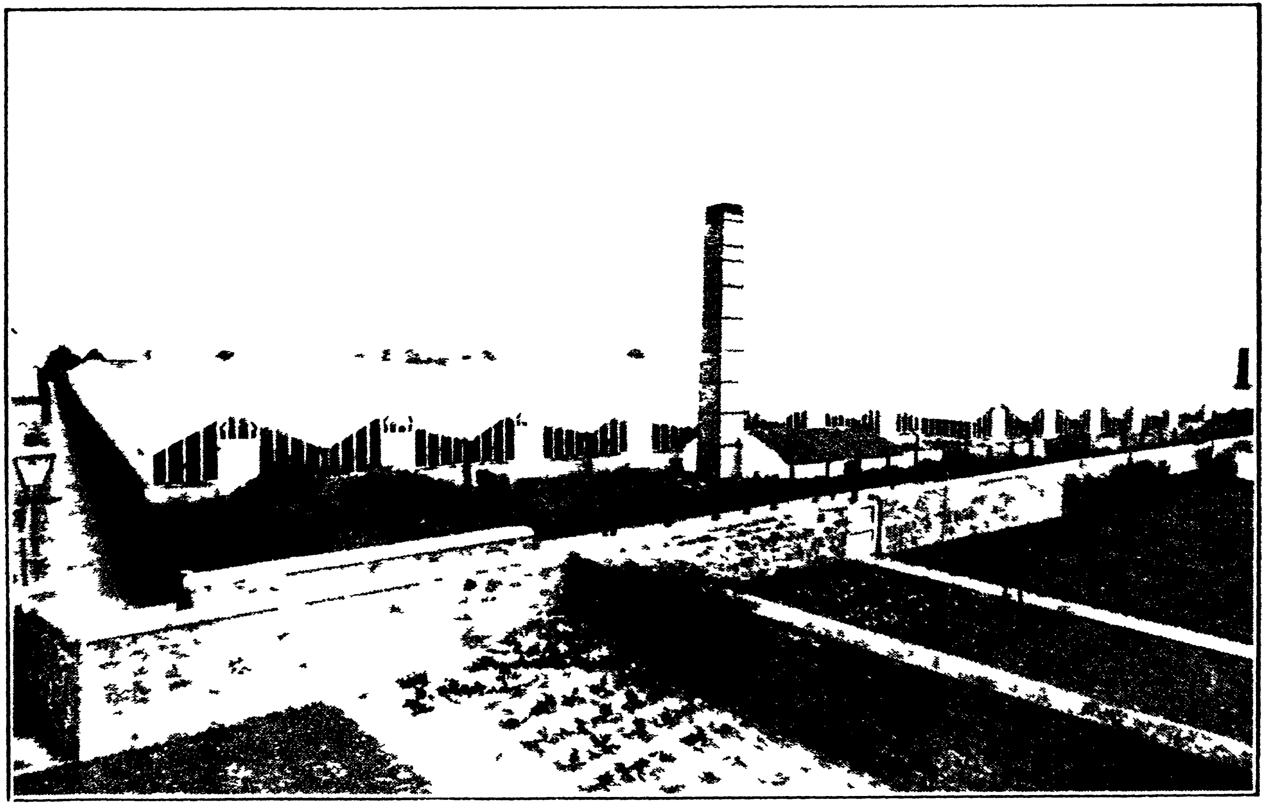
Endive is used either as cooked greens (the broad-leaved variety) or as salads (the curled variety). Endive stands both heat and cold better than lettuce. It responds to good treatment and the soil must be thoroughly cultivated. The crop is surface-rooted and is handled in a manner similar to lettuce, but requires to be blanched. Though less in demand than lettuce, it is considered a more profitable crop. Seed is sown in mid-October in rows 18 inches apart, the plants being afterwards thinned-out to 9 inches apart. On approaching maturity the plants are carefully moulded-up with dry soil, and the rows are then covered with wooden troughs or boarded at the sides and covered with corrugated iron.

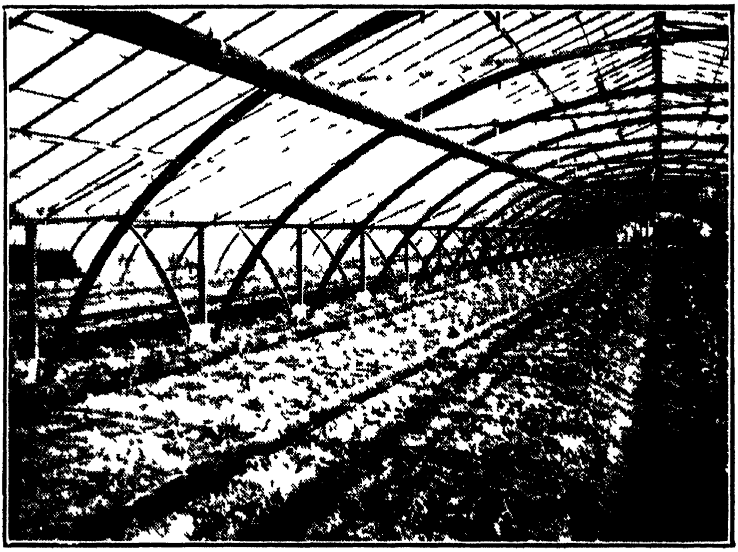
Chicory.—The demand in Scotland is very limited.

Tomatoes.—The imposition of 2*d*. per lb. on tomatoes during June and July should prove a very special boon to this industry. Tomato growing has long been the staple glasshouse industry in Scotland and there are no finer tomatoes produced anywhere. The foreign imports have usually depressed growers' prices artificially without affecting consumers' prices to any appreciable extent. This crop offers the most promising field for expansion.

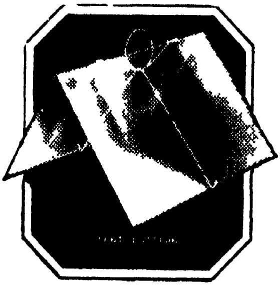
Twenty years ago much was written about this crop being seriously overdone, but since then the area has been trebled, until now there are at least 160 acres in Scotland. While the cultivation of this crop does not offer a short cut to wealth, it affords a satisfactory livelihood to a grower who can command sufficient capital to erect 1,000 feet (approximately one-third of an acre) of glass and is prepared to apply himself to the consideration of every detail in the growing of the crop. Incidentally, expansion of this industry would provide a large amount of labour, since it takes from £400 to £500 to work an acre of glass under tomatoes. Tomatoes are marketed from about May 1st until November 30th. The effect of the duties will be most noticeable during July, the glut period, but it will probably induce many growers to attempt to get their fruit into the market sooner, and may even induce some to plant more than one crop in a season.

Tomato growers are generally very loth to grow other crops, but in forcing vegetables under glass they should bear in mind that the crops of tomatoes are not reduced thereby. The maintenance of the soil in a state of activity is highly beneficial. Food material is retained, the bacteria are maintained actively working, and in those cases where a little heat is needed to mature the crops there is a decided benefit. Even though the





Portion of an iron built Span Roof Vinery at Westland, Holland



Chase Continuous Cloche

produce pays only for the coal and firing, the higher yields obtained justify the cropping. Many growers have the idea that it is an advantage to get the frost well into the soil, but this is not the case in the present position of early planting.

A fairly exhaustive account of the Scottish tomato industry was contributed by the writer in the *Scottish Journal of Agriculture* for July 1927.

Many of the lines of development mentioned in this article may be considered as complementary to tomato growing. A tomato-growing establishment is primarily erected for that purpose, and it is rarely wise to adapt to tomato growing structures built for other purposes.

Houses erected primarily for tomatoes may be used for chrysanthemums, sweet peas, bulbs, pot flowers, and for forcing vegetables. For those intending to take up tomato growing, the chief considerations are :—

1. *Site*.—This should be as level as possible. Houses on a slope are always more subject to mildew. Soil moisture is also difficult to maintain where the incline is greater than 1 in 100. The situation should be open, but adequate shelter should be provided. Houses should not be built on land which has been a poultry run without first taking some other crop (not potatoes) off the land before the tomatoes.
2. *Water supply*.—Large supplies of water are essential and are best obtained from a public supply. Surface water is likely to be contaminated with fungus spores.
3. *Drainage*.—An efficient drainage system is imperative. It is better not to rely on the original field drains but to instal a new system of 3 inch pipes, 10 to 20 feet apart.
4. *Soil*.—A deep, retentive, medium loam is the most suitable soil, for preference inclining towards the heavy side. Under the ordinary conditions of cultivation a heavy soil becomes more amenable each year, and it is well known that a soil inclined to be heavy will carry crops without sterilisation for a longer period than a light one. Depth is important. The potato is the worst crop to precede tomatoes. Where old meadow land is broken up for the crop there is great liability to attack by wireworm in the second and third years.
5. It is important to erect houses in such a manner as to allow of the maximum light and ventilation. The boiler and piping provided should always be considerably in excess of the maximum requirements. Low pressure hot-water heating system is the best.

The present all-in constructional cost varies from 25*s*. 6*d*. to 27*s*. 6*d*. per running foot for erections of one-quarter acre and upwards.[1]

Cucumbers.—Cucumbers are not consumed in Scotland to the same extent as in England and Wales, but the demand is

[1] "Culture of Tomatoes." Howells.

increasing. Growers intending to start with this crop will probably take it up as a side line to tomato growing. In many respects the requirements of the two crops agree, but the cucumber is more exacting as to soil, situation, and temperature.

I. It is imperative to have a soil which has not been exhausted and old pasture is best. Plentiful supplies of old turf are advantageous. (Where suitable land occurs good turf can be made in 2 to 3 years.) [1]

II. Plenty of water free from any possible contamination.

III. Ample heat, especially during the earlier part of the season.

IV. A slight slope to the south is preferable to a level site.

The seed is sown at any time from mid-December onwards. It is not advisable to sow early unless a temperature of from 65° to 70° can be steadily maintained. Where only a small area is to be planted, the seeds may be sown singly in 3 inch pots, half filled with soil and plunged in a propagating pit. Where a large number of plants is required, about 50 seeds per box (9″ × 15″) should be sown and covered with one-quarter inch of fine soil. The soil mixture for filling the boxes should be fairly rich. The boxes are placed on the pipes or in propagating pits. After 7 to 10 days the seedlings should be ready to pot into 3 inch pots containing heated soil. A suitable mixture would be two parts of fibrous loam and one part of well-rotted manure.

Very firm potting is a disadvantage. After potting-up give a good soaking, afterwards keeping comparatively dry at the roots to encourage fibrous root development. Keep syringed overhead daily. Repot when necessary into 5 inch or 6 inch pots and give support. The young plants should be kept at a temperature of from 60° to 70° and must never be allowed to become pot-bound.

The beds must be of an open texture and yet retain moisture and heat. A mixture of old turf two parts and fresh straw manure one part, mixed together and enriched by some artificials, is very satisfactory for this purpose. Use 20 lb. of steamed bone flour and 5 lb. of sulphate of potash per ton of soil. Make up the beds some time in advance of planting, and about four days before that operation make holes 20 inches to 22 inches apart with the patent planter.[2] Set the plants in the holes while still in their pots so that they become acclimatised before shifting. Cucumber growing entails much more careful pruning and training than does tomato growing.

In the present circumstances there should be a good opening for the cultivation of cucumbers in frames. Owing to the large

[1] By planting tufts of *Agrostis stolonifera mutica* at a distance of 8 inches apart.
[2] Plantal.

quantities of water required, it is imperative to choose a well-drained site.

Seeds should be sown in heat in the middle of March, one seed per pot, and transplated to their permanent quarters about four weeks later. The beds should be made up of equal parts of fresh stable manure and leaves mixed together and turned once or twice before using. Dig the ground the whole length of the frame and then take out a trench two feet wide and one foot deep running the whole length of the strip. Fill the mixture of manure and leaves into the trench, treading firmly and evenly, and fill up the whole ground to 6 inches above the original level with manure and soil. Place two shovels-full of special compost under the centre of each " light " and insert the plant there. The frames will need covering with mats until the end of the first week in June.

Melons.—The Cantaloupe melon is grown in a frame and treated in a manner similar to frame cucumbers.

Glasshouse melons or net melons need very similar treatment to cucumbers; in fact the two may be grown in the same house, although melons require more space than cucumbers.

Flowers.—*Cyclamen.*—As commercial plants these are becoming more valuable. They have a very long flowering period in winter and when well-grown are very attractive.

Seed is sown from September to November or in February in well-drained shallow pans filled to within an inch of the top with soil. The soil should consist of 2 parts loam, 1 part leaf mould, and 1 part sand. Make the soil level, water thoroughly, and sow the seeds thinly, covering with about one-sixth inch of soil.

Cover with a sheet of glass and keep in a cool airy place. The seeds germinate very slowly—the corm forming before the seed leaves appear. They usually take 6 to 8 weeks to germinate, after which they should be put near the glass to ensure sturdiness.

As soon as two leaves have formed, prick-off into small wooden boxes and return to the shelf near the glass. The most important consideration in growing cyclamen is water, which should be given sparingly and never over the corm. Careless watering is fatal.

When three or four leaves have formed (usually in February or March) pot up in 3 inch pots in a soil consisting of 2 parts leaf mould, 1 part sifted bullock manure, 4 parts loam, and sufficient sand. Keep in strong sunshine but in an airy situation where the temperature will not drop below 55° at night. They may be repotted into 4 or 5 inch pots using a similar soil. Do not over-water at this stage of their treatment. Remove to a cold frame at the end of May and cover with a screen. Pot-on into 5 or 6 inch pots and return to the frame. Syringe frequently during the summer.

Begin feeding in August with liquid manure and take them

into the house in September. Never allow water to splash over the corm.

Azaleas.—The two species usually forced are *A. indica* and *A. mollis.* There is a tremendous variety of colour now possible amongst the named varieties of azaleas.

The plants are imported from Belgium. As soon as they are delivered they should be plunged in water to restore turgidity to the roots. Pot immediately into as small a pot as possible, using a mixture consisting of equal parts of loam, leaf mould and sand. Never allow the soil to be dry nor the water to be stagnant. Keep in a cool, shaded house with a confined atmosphere and spray daily overhead. If not required in bloom early keep at 45°-50°. For early blooming bring them into a temperature of 50°-55°, and six weeks before they are required in bloom increase the temperature to 60°. Reduce the temperature by 5° for three or four days before sale. During the flowering period the plants should be ventilated well but not subjected to draughts. They require an abundance of water during their blooming period. Where they are not required in flower until Easter they may be grown continuously at a low temperature. Repot after flowering and give a liberal watering and plenty of ventilation. Plunge in full sunlight and water from time to time.

Ericas.—A number of different species and varieties are grown:—*E. melanthera*, October to February; *E. Willmorei*, December to February; *E. hyemalis*, January to March; *E. persoluta alba* and *E. p. rosea*, February; *E. Cavendishiana*, March to April, &c.

Cuttings are taken from young plants from December to April. Strong shoots about one inch in length are used and struck in a pan filled with clean sharp sand and covered with a bell jar. No bottom-heat is required. When rooted they are potted-up in thumb pots, using equal parts of sand, leaf mould and loam. When well established give plenty of air. Transfer to the frame early in spring and later to the open ground. In early autumn bring into a cool house and repot in soil consisting of equal parts of fibrous loam of a sandy character and leaf mould. No active organic matter should be used. Keep partly shaded until the roots are fully developed and then keep in full sunlight but at a low temperature. The plants should not be allowed to wilt, but on the other hand too much water is injurious, especially during the winter.

After flowering trim into a symmetrical form as heading-back keeps the foliage on the lower part of the plant. Repot each June and keep the root system active at all times.

Hydrangeas.—These are probably the most profitable of all pot plants.

Cuttings are often taken, from large stock plants, from August to September or from February to June, and are selected from top growths which in many cases will have already formed flower crowns. They should be 2 inches to 3 inches in length, be inserted singly and firmly in small pots, and placed in a cool,

shady frame to root. Water heavily when inserted and then sprinkle every morning. At first the leaves will droop, but as the roots begin to form the crown begins to grow. When struck in spring 5°-10° of bottom heat is required. Hydrangeas will not stand forcing quickly, as the root system develops slowly. When struck between January and June they are potted-up in 3 inch pots and potted-on as required. They should be out of doors by the end of June. To secure bushy plants, head-back once and pinch side branches once. After July all flowers should be removed. As autumn approaches lift and pot, using good-sized pots.

To ripen the wood, place the plants in a cold frame with abundant ventilation; keep cool and in shade.

After the first frost remove to a cool greenhouse or a cool light cellar until January. It takes about 12 weeks to force the plants into bloom. The temperature should be started at 50°-55°, raised to 60°-65°, and later to 70°. After they are thoroughly started the plants require a great amount of water, and when the pots are full of roots feed with liquid manure. Ammoniated alum 0·3 per cent. solution is used to give the blue colour.

Lilies-of-the-Valley are grown in very large numbers throughout the year.

They are planted in partial shade in a soil which is cool, moist and rather rich. Old stocks are liable to run-out in a few years, as the root stocks rapidly become crowded, so replanting should be carried out annually.

They are sometimes grown on hot beds during the summer, the crowns being stored in cold storage for use as required.

In indoor cultivation the crop is short-lived and lends itself very well to forcing. The crowns are French, German or Dutch, and to have an even batch it is essential to freeze them for a week or two. During the forcing they make practically no roots, neither do they take any nourishment from the soil, so that sand is the best medium for forcing. Thaw slowly, after which a very high temperature may be given at once.

Spiræa (Astilbe).—The dormant crowns are imported and may be stored in a cool cellar until required, but should not be allowed to dry out. After the crowns are potted-up it takes from 10 to 14 weeks to bring them into bloom, but much depends on the earliness of the season at which they are wanted in flower. The pots should be sufficiently large to allow for an abundance of water which later will be needed. A temperature of 50° at night is most suitable, as a higher temperature is liable to cause the flowers to be of short duration. From the time the sprays begin to show colour until they are fully developed, every potted plant should stand in 1 inch of water.

Marketing.—There is always a market for certain British-grown fruits and vegetables. The British grower commands a market because of the juiciness and tenderness of his product, and also because certain vegetables and fruits, particularly the raspberry, suffer severely when carried long distances. In the

home market there is a greater demand for fruit and vegetables than ever before, and this demand has to a large extent been created by the high standard of the imports from overseas. The demand is a more enlightened one that insists on a better-looking article. It is often said in a more or less supercilious manner that the public buys through its eyes rather than by discrimination as to quality. That may be so, and after all it is very natural. Though a coating of mildew may not affect the quality of gooseberries, no one would suggest that berries covered with the dirty brown, felt-like material would be other than repulsive, and this is true to a certain extent of all blemishes. The American packers of apples put freedom from blemish as the first desideratum in this fruit. It is absolutely essential that the home producer markets his produce in the best form possible. Some time ago an address was delivered on apple-marketing methods adopted in New Zealand, in which it was mentioned that by a voluntary arrangement nothing but first quality fruit was sold either at home or for export. The standard of production had been raised very greatly, and the percentage of inferior fruit now grown had been reduced to a negligible quantity. With the introduction of the Customs duties, it behoves all growers to see that their produce is of the highest possible quality. Many growers could always be depended on to market only first class produce, but many are somewhat indifferent as to this aspect. The expert packer always has the advantage, but this is more marked in glut periods than at any other time. Commercial horticulturists must realise that their commodities must be packed in the most suitable containers to please the retailer, be of uniform size and quality to please the buyer, and be free from blemish to satisfy all parties. A visit to the larger wholesale markets during periods of maximum production will convince the most sceptical. The badly graded, ill-packed, and roughly-handled produce is always left on the wholesalers' hands and usually finds its way to the street hawkers at a very low figure.

Grading.—The overseas and foreign packer has built up a reputation not so much by the nature of the package he uses as by the nature of the contents. The wholesaler and retailer know by looking at the label exactly what the package contains. The home grower must be able to guarantee first class produce, definite sizes, weights or quantities, and perfect grading.

Quantities of the same article.—This is a very important point. The retailer develops a market for a particular article and it is essential that he should be able to supply his customers day by day or week by week with this. Small quantities of any one article, unless it be of something which is a luxury, never find a ready market among the best of our retailers. They must be able to supply the public with repeats of most things. This is not possible in such fruits, vegetables and flowers as have a limited season, but even here great improvements might be possible in some cases by artificially extending the seasons during which the product is available. It cannot be expected that

retailers will change to home produce when this is available only for a very limited period.

Packages.—A visit to our leading markets will show great variety in packages. Pecks, half sieves, strikes, hampers, handles, boxes, chip baskets, sacks or bags, are all to be seen containing fruit or vegetables. With the exception of chips and boxes all these are returnable. Strawberries, raspberries, and to a less extent plums and gooseberries among the fruits are marketed in non-returnables. Tomatoes, lettuce and cauliflowers are sometimes sent in non-returnables but more often in returnables. In comparing the two types of packages, returnables and non-returnables, the matter may be approached from several viewpoints, viz.—that of the grower, the salesman, the retailer and the consumer. The non-returnable package should be a boon to the grower because in the first place he has a free market. In most cases the returnable package is supplied by a particular salesman and marked in a distinctive fashion. The salesman supplies the containers on the understanding, stated or implied, that all fruit marketed in them will be sent to him. This of necessity ties the hands of the grower, and he is under a moral obligation to send supplies to the salesman no matter what prices he is receiving. If he does not use the baskets they are still charged against him. It sometimes happens that while Glasgow market is glutted with supplies, Edinburgh is comparatively easy or *vice versa*. The grower who has packages only acceptable in Glasgow is thus at a disadvantage as he cannot transfer his despatches to Edinburgh, though the dealers often do. A grower using non-returnable packages can establish individual connection. Where the baskets are his own he can adopt a distinctive trade mark or design and by careful packing and grading establish a close bond between the retailer and himself. Returnable packages must be more substantial, take up valuable storage space, and the cost of transport is thereby increased. The wholesaler has to keep a staff checking and dispatching returnable baskets to and from the grower and to and from the retailer, and during the close season has to provide storage accommodation. The general adoption of non-returnables would lessen his oncosts considerably. From the retailers' point of view the advantages are equally important as storage is an important matter to him. His interest in non-returnables is finished when he empties them. Often he can dispose of the whole container full to a customer. It saves handling for these customers who buy large quantities and supplies a suitable container which need not be checked or accounted for. To the retailer the money sunk in non-returnables represents money sunk in an unproductive manner. From the consumers' point of view the non-returnable is more hygienic, and unnecessary handling is sometimes saved. The link between the consumer and a particular producer is closer and the consumer is often induced to purchase in larger quantities.

Much has been done by the National Marks to standardise

packing of tomatoes. A large number of the foremost packers are adopting the scheme. Many of those who formerly made an experimental essay contemplate this season packing all their produce under this scheme.

CYCLES IN ANIMAL LIFE.

A. D. MIDDLETON,

Bureau of Animal Population, University Museum, Oxford.

In the past it was customary to regard all changes in the numbers of wild animals as due either to the weather or some aspect of man's interference with the Balance of Nature. But nowadays we are beginning to realise that wild animals can rarely be said to be balanced in relation to their environment. Nature is, in fact, more often in a state of "unbalance." We are told by authoritative natural history writers that the smaller herbivorous animals constitute the food supply of the carnivores, and that any increase in the number of herbivores merely means an increase in the food supply of the carnivorous animals, which consequently increase in pace with their prey and tend to produce a more or less continual balance between the numbers of both. This theory is very reasonable, but, unfortunately, the facts concerning animal populations do not entirely agree with it; what really happens is often quite another story, and one which is certainly not at all simple nor easy to understand. Take, for example, the facts concerning rabbits and their carnivorous complement in Northern Canada, where environmental conditions are little influenced by man. We do not find the number of rabbits continually balanced by the foxes and lynxes: in one year rabbits may be swarming everywhere, providing a supply of food far in excess of the requirements of the fox and lynx population, while the next year they are so scarce that the Indian trapper may spend a week without getting a single "snowshoe," and the carnivores are reduced to a state of starvation undreamt of in the previous fall.

The periodic fluctuations of fur-bearing animals in Northern Canada are better known than those of most other animals, since the trade of the country and the welfare of the people are largely dependent upon the annual crop of furs; incidentally there are long series of statistics concerning the annual catch of different fur-bearing animals in Canada, which show up these fluctuations in a remarkable way and have made possible a detailed study of their periodicities which would be very difficult to achieve with any British animals. There is, of course, nothing surprising in the fact that the numbers of animals vary considerably from year to year: one would expect this to happen as the result of wet or dry summers, hard winters, and other common climatic variations; but a careful examination of

statistical records and evidence derived from direct observation shows that there is a remarkable regularity in the occurrence of times of abundance and scarcity for these animals. They have, in fact, regular cycles in numbers.

The cycles in numbers of the fur-bearing animals such as the lynx and the fox are perhaps the most obvious demonstration of this phenomenon, but when one looks further into the matter it is clear that the fluctuations of these carnivores are really due to corresponding and often more pronounced cycles in the rodent populations which constitute the basic food supply of both lynx and fox. The rodents which form the main food supply of most fur-bearing animals are rabbits, mice and lemmings. The existence of cyclic fluctuations among Canadian snowshoe rabbits has long been known, but the real course of the rabbit cycle has only recently been investigated and has been found to have a very regular periodicity of 9-10 years.[1] That is to say, rabbits reach a state of abnormal abundance at intervals of about ten years over practically the whole of the northern coniferous belt of Canada. For two or three years before the "peak" in this cycle rabbits increase at a tremendous rate, the number of young in the litter and the number of litters per year being greater than at the minimum position of the cycle; thus in the autumn of the peak year their numbers are excessively high, in spite of the heavy toll taken by carnivores. The lynxes, foxes, and other carnivores have meanwhile been increasing as fast as they can to cope with the unusual abundance of easily obtained food, but since they are larger animals and their rate of increase is very much slower than that of their prey, it is impossible for them to breed fast enough to maintain an even ratio between themselves and the rabbits. There are far more rabbits than the carnivores want, and in some peak years rabbits become so numerous as to be a serious plague, since they do a great deal of damage by their destruction of trees and agricultural crops. At this point it is obvious that something must happen to put a stop to the increase of rodents, and something usually does happen in the winter and spring following the autumn climax in numbers: an epidemic of disease sweeps through the overcrowded rabbit population, and by the next summer there are very few rabbits left as a breeding stock. Meanwhile the carnivores have reached very high numbers in the year of the rabbit peak, and may again breed prolifically in the following spring, since the effect of the rabbit epidemics will not be felt until the breeding season of the fox and lynx is well under way. The ravenous carnivore population quickly disposes of most of the rabbits which have survived the attacks of disease, and, though they turn their attention to birds and small rodents, there is no food-animal which can support the excessive numbers of carnivores when the rabbit abundance is a thing of the past. They may migrate for hundreds of miles in search of food, but

[1] C. Elton. "Relation of Animal numbers to Climate." *Proc. Conf. Empire Meteorologists, London*, 1929; and unpublished work.

since the conditions are similar throughout their life-range travel is wasted labour. Reduced to a state of starvation in the winter following the rabbit epidemic, the carnivores may themselves become the victims of disease, whilst with the scarcity of natural food they become an easy prey to the human trapper. Rapidly their numbers are brought down to a low level, and for a few years the "balance" may be perfect, with low numbers of both rodents and carnivores. Then the rabbits begin to increase again, and the cycle is repeated.

Every peak of the rabbit cycle is not so spectacular as this, and in some instances it seems that disease is not an inevitable consequence of high numbers, since a state of moderate abundance may persist over two years and be followed by a more gradual decrease to a minimum, probably due to decreased fertility. In some "peak years" the numbers may not be sufficiently high to cause comment, but the existence of the cyclic fluctuation is nevertheless obvious in statistical records.

The periodic fluctuations of the lynx, red fox and black fox are mainly controlled by the rabbit cycle, but with the white arctic fox matters are different. In the realm of the arctic fox there are no rabbits and the staple food-rodent is the lemming. Now the lemmings of the Canadian arctic have a cycle in numbers in exactly the same way as the rabbits farther south, but the lemming cycle is one of four—not ten—years. Consequently we find the white fox behaving quite differently from its red and black brethren, and an examination of the fur records for arctic Canada shows that it is subject to a pronounced short-period cycle of about four years, on account of the four-year cycle in the numbers of lemmings.

Although the Canadian fur cycles first attracted attention to this subject, and are still perhaps the most prominent example of periodic fluctuations in animal numbers, the existence of cycles is not by any means confined to North America. In every part of the globe where enquiries have been made it is found that cyclic fluctuation is the normal state of affairs for practically all wild animal populations, whether mammal, bird, insect or fish.[1] During the past few years special investigations have been made into the subject in so far as it affects British animals, and the results of this enquiry, though not providing such conclusive and spectacular evidence as can be obtained from the less civilised regions of the New World, show that animals in the British Isles are undoubtedly influenced in the same manner as in other parts of the world.

One of the first British animals to be studied from this point of view was the short-tailed field mouse (or field vole), since it was obvious, from the fact that devastating "mouse plagues" have been frequently recorded in history, that these animals do fluctuate in numbers considerably from time to time. Records were collected of every plague of field voles in Great Britain

[1] C. Elton. "The Study of Epidemic Diseases among Wild Animals." *Journ. Hygiene*, vol. xxxi, Oct. 1931.

during the past fifty years on which reliable evidence could be obtained; many of these plagues were actually only very small local outbreaks when the voles were noticed to be unusually abundant and causing damage to young forest trees, or were very numerous in hayfields, but others covered considerable areas of country. The severe vole plagues in the Border counties of Scotland in 1875 and 1892 were exceptionally prominent examples of these outbursts of rodent life. When the results of this enquiry were tabulated it was found that the years in which vole plagues had occurred fell into a comparatively regular four-year cycle, and throughout the whole period studied very few vole plagues were recorded which did not fit in with this cycle.[1] Thus it seems certain that although really big vole plagues occur at long and irregular intervals, there are local maxima in numbers about every four years in one part of the country or another. In some districts voles may never become noticeably numerous, being continually held in check by local conditions such as cultivation, winter flooding, exposure to frost, or abundance of carnivorous enemies, while in other cases the numbers at a four-yearly maximum may never be high enough to excite attention, although accurate census data would probably show the existence of a cycle. The size of a "peak" seems to be determined mainly by local conditions acting in conjunction with the cyclic influence, but all vole plagues, of whatever dimensions, are really periodic maxima of a continuously fluctuating population.

The great variation in numbers in the same place at different times in the cycle has been shown by comparable annual trapping censuses during the past few years, a variation as great as 100-1 from one year to the next being found in some localities. There is thus every reason to believe that British voles have a fairly regular cycle in numbers of four years. It has also been found that lemmings, voles and mice in Norway have a definite cycle of four years, and that the peak years of this cycle coincide closely with the maximum periods for British voles; furthermore, there is a high correlation between the lemming cycle of arctic Canada and both British and Norwegian cycles. In parts of Central Europe a similar short-period cycle has been found to exist, but having more often a three-year periodicity. It seems, therefore, that a widespread cyclic influence is affecting mice, voles, lemmings and other small rodents over an area embracing half the globe.

It may be appropriate to consider here the importance of mice and voles in agriculture. The plague of voles in Southern Scotland in 1892 certainly aroused great consternation and did a lot of damage, but agriculturists do not generally look upon the field vole as a pest of any significance in "normal" times. Calculations based on extensive trapping show that a population of 500 voles to the acre on rough pasture or hayfields is quite a normal concentration when voles are fairly numerous in such

[1] A. D. Middleton. "Cycles in the numbers of British Voles." *Journ. Ecology*, vol. 18, 1930.

areas as the Border counties, while in certain localities such as enclosed forestry plantations they have within the past few years reached a population of at least twice this figure (over 1,000 to the acre). It has been found that a field vole eats on the average about half an ounce of grass daily, approximately 11½ lb. per annum; thus a population of 500 voles to the acre would consume at least 51 cwt. of grass annually. Also, by eating only the bases of the grass shoots, especially in winter, the voles destroy at least twice as much grass as they actually eat, so that in the above conditions the farmer may be losing grass at the rate of 5 tons per acre per annum without being aware of the fact. It will readily be seen that in quite ordinary conditions the presence of an average vole population on sheep pasture may reduce the possible productive capacity for sheep by anything up to one per acre. The effect of a heavy vole population on the hay crop must also be considerable, since a hayfield is a favourite habitat of these animals and one in which they concentrate to a greater extent than in grazed pasture land.

Rabbits and hares in various parts of the British Isles have long been known to fluctuate considerably in numbers from one year to another, and this has generally been put down to the weather, over shooting, and other obvious causes affecting the numbers of such animals; but strangely enough it now seems certain that rabbits and hares have natural periodic fluctuations in numbers of a significance quite outside the effects of mankind and the more straightforward weather factors. It is difficult to get statistics which can be used as an index of the rabbit and hare populations, but many series of such records do show a pronounced cycle with an average periodicity of about 8-9 years, and the evidence derived from direct observation confirms the existence of such a cycle. Rabbits and hares are subject to various diseases such as coccidiosis, tape-worm infections, syphilis, and possibly tuberculosis, and at the climax of a period of increase these diseases become especially prevalent, with fatal results to the rodent population. The summer of 1931 was remarkable for the great reduction, brought about by disease, in the numbers of rabbits and hares in many areas in England, where 1930 was a year of exceptional abundance.

In spite of the fact that many people believe that natural phenomena have little control over game birds, there is a good deal of evidence showing that grouse and partridges have cyclic fluctuations in the order of 7-8 years. In this respect it may be mentioned that the Norwegian willow grouse, ptarmigan in Labrador, and ruffed grouse and other game birds in America have prominent cyclic fluctuations. British squirrels appear to have been subject to particularly violent fluctuations in numbers, associated with outbreaks of disease, during the past century. The American grey squirrel, which has been introduced into many districts in England and Scotland and has spread in an alarming manner, now shows signs of this tendency to fluctuate, since during the winter and spring 1930-31 its numbers, in

southern England at any rate, decreased to a remarkable extent owing to epidemics of disease following an extremely high peak in numbers during 1930. But there is now every indication that a recovery of these pests is beginning, and we may expect a revival in their numbers during the next few years, though the nature of their cycle is not yet clear.

The instances of periodic plagues of insects and the mysterious fluctuations in fish numbers would take too long to enumerate here, but there is every reason to believe that these inequalities in animal life are fundamentally brought about by similar factors to those which influence mouse populations and Canadian fur cycles.

What are the causes of these cyclic fluctuations in animal life in all parts of the world? The answer is still uncertain, since they show no constant correlation with any of the known and recorded data on climate, such as rainfall and temperature. It does, however, seem most reasonable to look to a meteorological or climatic influence for the solution of the problem, and meteorologists admit that there may be many factors influencing plant and animal life, which, though their effects are obvious, have not yet been discovered. Light and other forms of solar, stellar and cosmic radiation are known to have potent influences upon physical and living matter on the earth, but few of these factors have been known and measured for a long enough period to show whether their action has a cyclic variation or not. Meanwhile the study of the nature and working of these animal cycles may partially solve the problem in advance of climatological knowledge and even indicate the nature of the meteorological factors concerned, of which we are at present completely ignorant. Whatever be the cause of cycles in animal numbers it is obvious that it has very marked effects upon life, and it is only reasonable to suppose that many other animals, not excluding man himself, will be found to be considerably affected by the same influence.

Since rodents and herbivorous animals are most directly affected by these cycles, it seems likely that the cause is some factor or combination of factors acting directly upon the plants which form the food supply of the rodents, although it is by no means impossible that the reproductive power and general stamina of the animals could be influenced directly by some form of radiation. If the cycle works through the food it is likely that all animals eating the same type of food would be affected in some way, and in this case we should expect sheep and agricultural stock to show some reaction to the factors which are so potent for grass-eating animals like voles and rabbits. It appears most likely that voles and rabbits would be influenced more by a *qualitative* than a quantitative variation in the plants, as there is rarely an absolute scarcity of grass and ground vegetation. Any change in the vitamin content, for example, would be likely to influence breeding or resistance to disease. It is difficult to ascertain whether sheep are in any way influenced

by the cause of the vole cycle, as their numbers are controlled artificially, and in most cases winter feeding on roots, kale, &c., would tend to keep them at a fairly constant level of health and fertility. It would be interesting to examine records over a number of years of the average *weight* of sheep, and fertility rates, on the hill pastures of the Border, where artificial feeding is not resorted to and any variation in the food-value of pasture would be most likely to be reflected in the weight or fertility of the sheep; unfortunately it is at present almost impossible to obtain reliable records of carcase weights, and accurate data on fertility are not easy to obtain for the same stock over a long series of years. It is interesting to note that the wild sheep of the Pamirs have a natural cycle in numbers of about 20 years, accompanied by periodic epidemics of disease.

The study of diseases which break out among wild animals at their periodic peaks in numbers is of obvious importance, since some of these may be the root of epidemics among agricultural stock or human beings. Also these diseases are obviously efficient means of reducing the population of such animals as rabbits, rats, mice, voles, squirrels, &c., and their study may well give us the power to use specific diseases in the control of agricultural pests. Very little is known about the natural diseases of wild animals, and it is a subject which, in conjunction with research into cyclic fluctuations, merits a great deal more attention than it receives at the present time.

THE BIOLOGIST on the FARM.—No. XLV.

Sir J. ARTHUR THOMSON, M.A., LL.D. (Edin.; McGill; Calif.; *et* Aberd.),

Emeritus Professor of Natural History in the University of Aberdeen.

The Taste of the Black Slug.—One of the signs of Spring coming in is the appearance of the Black Slug, *Arion empiricorum*, which has been lying low through the winter. If we were not slaves of prejudice we should recognise it as a very handsome animal, with its velvety black skin quaintly patterned, the line of yellow round the margin of the foot, the two pairs of "horns" or feelers, and its pleasant proportions. It is also an interesting creature that deserves further study. Thus it carries to a vanishing point the reduction of the ordinary snail's shell, for there is nothing left save a few corpuscles of lime. While its staple diet consists of plants living and dead, or scattered fragments of plants, it has been known to break its vegetarian rule and indulge in animal food. Like many of its relatives it has a highly developed sense of taste, for many of the snails are very particular about what they eat, becoming gustatory specialists. The Black Slug is not that, but it puts its sense of taste to a quaint use, far from common among

animals; it uses its taste in connection with reproduction. Let us tell the strange story, so far as we know it.

At the posterior end of the flat " foot " or sole, on which the animal creeps, there is a special gland which secretes a particular kind of slime, different from the ordinary mucus which is exuded in front. The special posterior gland becomes very active at the breeding season, and the Black Slug swallows the secretion with gusto. But the gland has no connection with the reproductive organs. When one ripe slug meets another, the first turns so as to lick the exudation from the second, and the second behaves similarly in regard to the first. Thus the two bodies are twisted round into a peculiar position, which happens to be suited for the pairing or coupling. Slugs and snails, like earthworms and leeches, are bisexual or hermaphrodite, yet cross-fertilisation or mutual insemination always occurs, A inseminating B, and B inseminating A.

It is well-known that the senses of sight and hearing, touch and smell, are often brought into the service of courting in the Animal Kingdom; but there are not many cases in which taste is similarly utilised. But there are several male crickets with a dorsal gland whose secretion is licked off by the female, and there are some curious flies that carry this rather farther. The male offers the female a drop of secretion, sometimes holding it to her mouth, sometimes placing it on her eye! In certain species the male encloses a food-gift in a sort of silken " toy-balloon," as Dr. F. W. Edwards tells us in the very interesting " Standard Natural History " (1931), edited by Mr. W. P. Pycraft. A quaint subtlety is that the " balloon " may come to mean more than the booty inside. The food-gift or the exudation-droplet may serve as a peace-offering, or it may pre-occupy the female's attention, or it may be a love-philtre, some say an anæsthetic. *De gustibus non disputandum est.*

Buffalo Fly in Australia.—This fly is believed to have been first introduced from Indo-Malaya into Australia about a hundred years ago, but its ranks have been often increased and it has gained a firm footing in the Northern Provinces. It attacks all sorts of cattle and horses, and though it does not kill or carry disease, it does much harm by sucking blood and inducing " fly-worry." Dr. R. J. Tillyard tells us that the point when bovine toleration is replaced by nervous strain is reached when there is a concentration of about a thousand flies to each beast; and we can well believe it. At Kimberley it is the worst of the cattle pests. We are noting it simply as an instance of the tax man has often to pay, not for any particular heedlessness, but because of the implications of any marked change of distribution. The natural extension of the fly is somewhat checked by dry belts, but the more positive method of introducing parasitic insects to counter the intruders in badly infested areas is also being tried with success.

A Fly quicker than a Bullet.—Life is beginning to get busy again as the sun becomes more generous. We suppose that

nothing dynamical happens in living creatures that is not consistent with the laws of energy that have been established for non-living things; but it is sometimes very difficult to believe this, except on general grounds. Many animals expend so much energy in proportion to the amount of fuel or food they get. And the engines or muscle-fibres with which they work continue to be so puzzling. Transparent threads of very watery living matter, enclosed in very delicate films, do most of the animal's hard work; and the number of successive contractions in a short time is often extraordinary. A quickly flying bird may make from two to twelve wing-strokes in a second, but a hive-bee may attain to nearly two hundred, and a fly to a hundred more.

Many small birds attain a velocity of forty miles an hour, and swifts, which are probably the fastest birds, may reach a hundred. But how slow this is compared with the velocity of some of the insects. Professor C. H. T. Townsend tells us that certain bot-flies (*Cephenomyia*), observed from a plane at an altitude of 7,000 feet were travelling " well over three hundred yards per second. This means six or seven hundred miles an hour, fast enough to overtake a musket ball or the shell of a Big Bertha." What can we say but " Prodigious ! " and it must be true when a Professor says so. Professor Townsend says that if he could make a flying machine as engineeringly effective as the high-flying bot-fly he could go round the earth in one daylight. Without an aeroplane it takes a modern human traveller about sixty days for the " grand tour " of 24,000 miles; and even then he requires to be lucky. We hope there is no snag in these calculations, for it is comforting for the naturalist to be told that organisms can occasionally outdo mechanism, even at the game of speed. But of course we do not mean that a real bot-fly could go round the real world in twenty-four hours. We were talking statistically.

The Newborn Kangaroo.—We have previously referred to the evidence that the newborn kangaroo creeps of itself into its mother's pouch or marsupium, and to the dismissal of the old view that the mother takes the youngster (there is usually only one) in her mouth and places it on a teat in the pouch. Long ago all competent naturalists gave up the theory, anatomically contradicted, that the young one uses some internal communication between the oviducts or vagina and the pouch. A circumstantial account of what actually happens has been recently given to the Zoological Society of London by Dr. W. D. Walker, an Australian physician, who corroborates the modern view.

When about to give birth the mother kangaroo sits down on the base of the tail, with the rest projecting flat on the ground between her legs. The blind and very naked young one, not much over an inch long, even in a big species, is liberated from the " cloaca," and begins at once to crawl upwards towards the opening of the pouch. The mother licks part of the route, but does not touch or help the young one until long afterwards. The clawed fore-limbs of the new-born kangaroo are more

strongly developed than the hind ones, and they are used in a "hand over hand" movement, in which the mother's hairs are firmly gripped. There seems to be an inborn obligation or tropism in the young marsupial to creep *upwards*, and this helps in a general way as an automatic guide to the pouch. In certain smaller marsupials some of the new-born young, very small and very weak except in climbing, never reach their destination, and must soon perish. In some cases there are more young ones born than the pouch could hold; and there are not teats for them all, as happens occasionally in the sow. Adaptations are not always perfect.

There are many different species of kangaroo and general statements are risky, but in some of the larger kinds the young one frequents the pouch for two or three months. After it has gained strength it comes and goes, and it is one of the quaint sights of the world to see a young kangaroo jump into its mother's pocket and then look out tentatively. The mother is careful of her pouch-youngster; the father is said to be indifferent, and the fact is he has not much opportunity of making his progeny's acquaintance.

The Drumming of Woodpeckers.—In many ways woodpeckers are peculiarly interesting. Think, for instance, of their striking adaptations, such as the strong pick-axe beak, useful in making holes in trees, or the stiff feathers of the tail which serve as a prop when the birds are hewing hard, or the peculiar arrangement of the toes, two turned forwards and two backwards, admirably suited for climbing. Then they have very interesting habits, such as that of storing acorns in neatly made holes in trees, a device which has almost become an obsession in the California Woodpecker. But we wish to say a little about the "drumming," which is so often heard, even when the bird is not seen. It is most marked in the Greater Spotted Woodpecker, and seems to be a method of excited signalling, especially at the courting time. It is made by both sexes,—a peculiar vibratory sound with great carrying power, for it can be heard from over half a mile off. It is usually regarded as instrumental "music," supplementing the woodpecker's laughing calls and other sounds which are obviously vocal. According to an old theory the peculiar drumming is due to vibratory movements of the head while the beak is thrust into a cleft in the tree, but the generally accepted view is that the bird makes the sound by hammering on a branch with its beak, the movements being so rapid that the head "presents a blurred appearance." Now many people have seen the bird moving its beak up and down with great rapidity, but that is not incontrovertible proof that the sound is actually produced by the hammering. And the interesting heresy has been recently started by Sir W. Beach Thomas, a naturalist of distinction, that "the sonorous outburst comes from the bird's throat, as does the cooing of pigeons, the hoot of owls, the purring melody of the nightingale," or any

other love-music. In short he believes that the "drumming" is vocal, not instrumental.

A convincing observer, Mr. N. Tracy, who has lived for ten years among Greater Spotted Woodpeckers, states the prevalent impression when he says :—" They generally seem to choose a perfectly dead branch, preferably one with a crack running down it, and the impact of the beak with the wood can be plainly seen." But it must be noticed that Sir William Beach Thomas does not deny what is visible, namely, the rapid up and down movement of the head; what he doubts is that the beak strikes the wood and thus produces the noise like hammering. " And while it moves its head it makes a guttural call to its mate, just as does the nightjar moving its head from side to side on its bough." But why, apart from healthy scepticism, should he doubt what seems, on the face of it, to be rather obvious. His answer is that it is impossible with so small and light an instrument as a Spotted Woodpecker's head and beak to produce by striking dead wood a sound which can be heard a mile off. Moreover, on a dead branch which had been for some days well drummed on, he found no mark of any kind! With this interesting scepticism well started, more observations must now be made; and the Biologist on the Farm would suggest that some of his readers may find opportunity to contribute to the solution of an interesting problem.

Before leaving the subject for the present, we may refer to the instrumental or percussion sounds which are made by various birds. Very familiar is the " clap " of pigeons when their wings strike one another smartly above the back. A similar snap is produced by nightjars and by the South American Manakins. Many people have heard in a " Zoo " the castanet-like rattle which the White Stork produces by clashing its jaws against one another. Mr. W. P. Pycraft in his invaluable " History of Birds " (1910) refers to the less familiar remarkable noise made by the Black Penelope, a game bird of Guatemala, which " occasionally pitches suddenly earthwards with outstretched wings, and produces a crashing rushing sound, which has been likened to the sound of a falling tree." Much discussed is the " bleating " or " drumming " of various snipe of both sexes at the breeding season. From a great height they descend with a prodigious speed, holding the tail fully expanded. The two outermost tail feathers, peculiarly modified in structure, are held out at an angle to the axis of the body, and it is their vibration, as the air rushes over them, that produces the sound. This can be verified experimentally. The " heather-bleater," as it is sometimes called, may be said to have made a toy, if not a tool, of its tail.

The Riddle of Migration.—This is the time of year to turn again to the problem of bird-migration, to which we have often referred in these studies. There is a new gleam of light in Professor Rowan's " Riddle of Migration " (1931), which lays stress on the duration of daylight, a factor long since recognised

by Sir E. Sharpey-Schafer of Edinburgh. Dr. Rowan has particularly studied the crows and juncos in Alberta, his inquiry being mainly concerned with the immediate stimuli which activate hereditary predispositions to migrate, and inborn qualities which make migration more or less successful. Granted the hereditary endowments, established no doubt by prolonged natural selection, what are the trigger-pulling stimuli in the autumnal flight to winter quarters? One thinks of the increasing cold, the scarcity of food, perhaps the reduction of ultra-violet rays, and so on, but Dr. Rowan regards the varying length of the day as the most important external factor, and it may be noted that at Edmonton, where he worked, the duration of daylight was nineteen hours on June 21st and less than nine hours on December 21st.

To theorise is easy, but Rowan has experimented. In early winter he put numbers of juncos (related to our buntings) in cages with electric light, and increased the illumination by five minutes each evening, until in January they were being illuminated up to 11 p.m. This seemed to suit the birds very well, though they normally migrate to southern winter quarters, as far off as Mexico. The male reproductive organs, which dwindle very markedly after the breeding season, attained their maximum summer size, and the birds sang, even in unheated cages. It may be noted here that "control" birds in cages with ordinary daylight remained in the non-breeding condition. On the other hand, those kept in non-illumined cages with artificial moving bars, which insisted on great activity on the bird's part and kept them long awake, showed full vigour in their reproductive organs.

When the juncos were released they showed no inclination to leave the experimental station. This was true both for those with gonads at maximum size and for those with the organs entirely quiescent. This confirms the view that birds usually migrate when their reproductive organs are in a transitional stage, either waning (after breeding) or waxing (before breeding), when the endocrinal or interstitial tissue of the gonads is most abundant or active. When "experimental" birds in this transition stage, either waning or waxing, were liberated in mid-winter, 40 to 80 per cent. of them disappeared. Somewhat similar experiments were made with crows, but we need not go into these.

In further experiments the number of birds utilised must be greatly increased, but a preliminary case has been made for Rowan's theory that the internal trigger-pulling stimulus of the migratory activity is to be found in the reproductive organs, and particularly in their endocrinal or hormone-making tissue, and that this is directly influenced by the seasonal changes in the duration of daylight. It is evident that the liberating stimuli which operate in a tropical area, where the seasons are but slightly punctuated, may be different from those which operate in birds like the juncos, which are summer visitors to the far

north; but Rowan does not pretend that his interesting theory has universal application.

Nature of Vitamins.—The general biologist has unfortunately or fortunately, as you like to look at it, to try to understand a little about many things with which he can never have an intimate acquaintance. This is certainly the admission of the Biologist on the Farm, who is not, however, inclined to resign from his ambition because he may occasionally burn his fingers! Although few general biologists can have much first-hand knowledge of ferments, one cannot be a biologist at all nowadays unless one understands a little about the manifold role they play in life. The same is true of many other things, such as hormones and vitamins.

So we make bold to give a biological cheer over the step recently made in the isolation of "calciferol," which is believed to be vitamin D in a practically pure state. The theoretical importance of the step is that we have here for the first time a close description of the chemical and physical characters of what seems to be an isolated vitamin.

It may be recalled that vitamins are elusive substances present in small quantity in certain foodstuffs, and playing a part in the routine of life (metabolism) or in development and growth, so essential that their absence spells disaster. There are various kinds, usually named after the first few letters of the alphabet (A to E, or further), and with diverse properties, such as working against scurvy, rickets, bad teeth, sterility and so on, or in subtle ways promoting growth and positive health. They are widely distributed in all natural diets.

Vitamin D, whose isolation has been effected, is abundantly associated with certain fatty substances, notably cod-liver oil; it occurs sparsely in milk and butter; there are just traces of it in green leaves and fruits. It prevents and cures rickets, and Mrs. Mellanby has proved up to the hilt that full health in children is impossible in its absence. It is conspicuously necessary for the proper development of the teeth and jaws.

About a dozen years ago the remarkable discovery was made that exposure to ultra-violet rays made certain foodstuffs behave as if they contained vitamin D; and it was shown that the irradiation produced an intensely active substance called ergosterol (abundant in ergot and yeast) which gives rise to vitamin D. This ergosterol is a chemical companion of cholesterol, which is associated with most animal fats and vegetable oils; and thus it became more intelligible how exposure to irradiation induces a supply of vitamin D in an exposed animal, or in exposed fatty food which was not in its untreated state anti-rachitic. So we can understand why milk and butter should have more vitamin D in summer than in winter. In the long run, it must be understood, the vitamin comes from the plant world, for even the cod-liver oil must be traced back, link after link, to the diatoms and other simple plants that form the floating meadows of the sea. After all, these valuable food-

stuffs, whether staple or accessory, represent bottled sunshine; and so the world goes round and round. This, at any rate, is within the Ecologist's province, and at the foundation of farming.

The bulk of living matter consists of collocations of " the big four " chemical elements—carbon, oxygen, hydrogen and nitrogen, but over a dozen other elements are present in very minute proportions. After making a few exceptions, such as the big percentage (shall we guess at 2?) of combined calcium in a large-boned animal like a horse, what strikes one is the minute representation of the others. Of the seventeen or so bio-elements which find general representation the "big four" occupy 96 to 99 per cent. of the whole organism, of which, however, water counts for 75 or more in ordinary living matter.

Iron is essential to the molecule of red blood-pigment hæmoglobin, which is essential to backboned animals, in capturing oxygen and carrying it to the tissues, but the percentage of iron in the red blood corpuscles by themselves is only about 0·4, a figure to be greatly reduced when we consider the body as a whole. Similarly the element magnesium is an essential part of chlorophyll, on which the life of all green plants depends, but the percentage of magnesium in a pine tree may not be more than 0·003. We suppose that such essential elements as iron and magnesium are mainly important because they link others together. They are keystones in the architecture of the molecule, say of hæmoglobin and chlorophyll respectively. It is very plain that in the realm of life a little may go a long way.

Now this is very strikingly illustrated in regard to vitamins, and we wish to quote a fine sentence from the report on the subject recently published by the Medical Research Council. " It seems almost incredible that a particular addition to the food so infinitesimal in amount, taken into the child's body for distribution to every part of it, should be so potent in its deep-seated activity as to make all the difference between crippling and disease on the one hand, and healthy life and development on the other. Similar instances of the significance of the ' infinitely little ' are provided, of course, by the other vitamins."

No one can ponder over achievements like the isolation of vitamin D without realising the extent of the influence which Biochemistry and Biology in general are already exerting on human life. And no limit is known to what science may do.

Before leaving the subject we may notice that three Swedish investigators have recently announced the discovery of a, or the, chemical precursor of, vitamin C, which works against scurvy. They have found this source in narcotin, one of the less toxic alkaloids present in opium. It occurs in various unripe fruits and vegetables, such as oranges, tomatoes, white cabbage and potatoes. It disappears with ripening, which agrees with what is well known of vitamin C that it tends to disappear from leaves and fruits when these are boiled or exposed to oxidation.

Pure commercial narcotin is not anti-scorbutic, but the Scandinavian investigators found that this virtue can be in some measure acquired by exposure to irradiation from a quartz mercury vapour lamp. A new use for opium?

THE FURTHER DEVELOPMENT OF AGRICULTURAL PRACTICE.

H. G. MILLER, B.Sc.,
Rothamsted Experimental Station.

It is safe to assert that there are, to-day, more potentialities —economic, mechanical, educational, scientific and political— for change in agricultural practice than there have been for at least a century. The first two are closely linked and are in present circumstances the most important. Science meantime plays a secondary rôle, although it must always be an important factor in easing economic difficulties in many ways, such as by reduction of losses from disease. But it has so encouraged production as to cause serious economic difficulties, and is unlikely to regain its former position until sufficient fresh fundamental research has paved the way for further application to practice. For instance, the scientific understanding of the markedly beneficial effects of fallows and intensive soil cultivation on crop yields might lead to artificial means of obtaining the same results more quickly. Again, more fundamental research in genetics may lead to big improvements in the art of breeding farm animals.

Our chief concern here, however, is with the potentialities possessed by mechanical developments, linked with economic necessity, for changing our present practices. Engineering or other developments for the improvement of agricultural production in this country cannot alone solve our agricultural problems. Any developments here, not themselves adapted from abroad, will soon be copied overseas and any temporary advantage gained be quickly lost. We have, however, our very important home market, particularly for perishable produce, and can thus afford to have slightly higher costs of production than those of overseas producers without a corresponding handicap in retail costs.

The development of stock farming is less dependent on new mechanical ideas than is that of cropping, although feeding practice may be altered considerably if young greenstuff, such as grass, can be economically dried, or if the root-break is still further reduced in size. There is however plenty of room for breeding developments, particularly with regard to performance. With changing popular tastes the size, type and class of animals may alter, because, as standards of living rise, the demand increases for lighter meats like poultry and lamb; the demand for milk, too, is capable of big expansion.

The farming systems of this country have developed gradually

from systems that are centuries old; but they are still based on the assumptions that a quadruped is the chief power unit on the farm and that human labour is cheap. Both require modification. To-day there are new power units, possessing many new features, and the cost of labour has increased. Our great problem is to increase the value of the output for every £100 spent on wages.

The Power Unit.—Tractors are the most important new source of power on the farm at present. Until recently their popularity was increasing only slowly, owing largely to the mechanical imperfections of earlier types and also to failure to grasp their potentialities. To-day tractors are highly reliable, although still being rapidly improved in design, in type of wheel, in nature of fuel used and other points, but the conception of the tractor as a mechanical horse is still too prevalent. This belief is seen at its crudest when a tractor is used to pull a train of implements each originally designed for horse work, although possibly justified during what has been called "the transitional stage." Its ability to speed up work and to undertake quite new operations—a point deserving special emphasis—offers great scope for exploitation by original minds.

The critic may well ask what possibilities exist in Scotland, when the growing season is practically over before harvest is completed. Catch-crops would have little chance of success; but that is only one line. Two others are given here, and, doubtless, readers will think of others more important.

(1) Nitrates, it is well known, are washed out of the soil by rain. The loss is greatest in winter and on bare ploughed land. It is much reduced on grassland, or where there is a growing crop to take up a proportion of the nitrates as formed. It is therefore beneficial to plough as late as possible. Yet the good farmer presses forward with the work. He feels proud if he has carted out large quantities of dung in the autumn—yet much of its value is washed away. His lazy neighbour may be far behind with his work—and is rewarded by escaping these losses. By using a tractor all this work could be left till later in the season without the fear of falling behind; but this raises the problem of how best to prevent the horses, even though reduced in numbers, "eating their heads off" in the stable during the winter.

If stubbles were left for a few months longer before ploughing, more might be undersown with the cheapest of grass seeds to minimise leaching losses, and also to provide keep for sheep; but the importance to certain soils of weathering by frost must not be ignored.

The sowing of wheat after potatoes is a practice designed to prevent the loss of fertility which occurs on bare ground in good tilth. But this loss must still be great because the young wheat plant is so backward. The loss would be less if a field looked quite green by the middle of December, or earlier. Can the tractor help with this problem? "Winter-proud" wheat would cause little anxiety where there were sheep.

(2) The root crop, swedes and turnips, which is regarded as a cleaning crop, involves a considerable wage bill. Might not a tractor do the cleaning more cheaply, not necessarily during the root year but on some quite different occasion? May not the root crop come to be regarded, not as a cleaning crop, but as a crop for clean land? A bare fallow is now regarded as a more economical proposition in many districts than it used to be, provided the operations are done cheaply and effectively with a tractor. But much can be done, under suitable weather conditions, without the loss of a whole year. There are considerable opportunities for spring cleaning operations before sowing roots, involving too much work if attempted with horses only.

The exploitation of the rotary movement of the internal combustion engine has only just begun. The power binder is one of the first and most successful examples, particularly with laid corn. Yet as long ago as 1847, Hoskyns, in search of new and more thorough methods of soil cultivation, was speculating in his "Chronicles of a Clay Farm" on the transmission of the revolutionary movement of the steam engine to some sort of rotary cultivator. This development is now successful for market gardening, though it has still to reach the field scale.

The number of hilly and rocky fields in Scotland presents serious difficulties to the development of power-farming. This will be further considered below. Apart from these farms, it should be possible to justify the possession of a tractor where about 80 acres, or possibly even less as new ideas develop, come under the plough annually.

Electricity is another source of power, but its development for many agricultural purposes has scarcely begun. At present its value for land or farm work at any distance from the steading seems distinctly limited; but its development would save a great deal of labour in and about the steading, particularly in threshing and the handling of straw.

"Mechanisation." — The development of sources of power has opened the way for the invention of entirely new implements and for increasing the size and capacity of those already fairly fully developed, like ploughs and grain-drills. This all tends to increase the output per man employed and to reduce the number of hands necessary on a farm.

Mechanisation in its most extensive application means a really drastic reduction in labour requirements. Do we need to consider this in Scotland? Will not a smaller reduction in the wage bill suffice for the continued soundness of our present systems, improved with the aid of new scientific knowledge?

Our farming systems, in their gradual evolution, have been very carefully and skilfully developed to keep a constant number of farm hands employed in the most effective way throughout the year. The different operations on the different crops dovetail into each other with great neatness. The Lothian 6-course rotation is an outstanding example; casual workers still being required, of course, for certain special jobs like potato-lifting.

New inventions may save labour on one or two particular operations in the year, thereby, to some extent, upsetting the existing balance, and requiring some reorganisation to make the most of them; or new inventions may save labour throughout the whole cycle of farming operations, as in the case of the combined harvester-thresher. The effect of its introduction is in striking contrast to that of the binder. The combine reduces the number of regular farm hands; the binder reduced the number of casual workers formerly required for harvesting. Speeding up harvest in this way helps on the autumn work, although it is of doubtful value in Scotland to cut down wet day winter jobs like threshing.

The combine is much discussed and criticised to-day. A machine of the present size can deal with 250-400 acres per season; obviously, cheaper machines of smaller capacity are required for Scotland. Their popularity is rapidly increasing. While four were used in the three Prairie Provinces of Canada in 1924, according to Mr. J. E. Newman, 9,000 are at work to-day. In the 1931 English harvest ten machines cut 1,425 acres. The combine is expected to prove suitable to the large flat fields found in some of the drier districts of England. Nobody appears to have been so rash as to suggest there is a place for it in Scottish conditions. Yet a combine, along with a grain drier, requires fewer dry days at harvest per unit area of grain than the binder; the idea is certainly desirable from the amount of labour it saves; and it should be possible to adapt and modify types of machines to meet Scottish requirements. A smaller type requiring less power and weighing less heavily on the ground might work economically in our usual size of field, particularly if the cutter-bar were in front. A combine with only a 5 ft. cut will shortly be on the market. Our heavier yields demand shorter cutter-bars than are found on American machines, otherwise the threshing apparatus would soon be choked. Sloping fields are probably a more serious obstacle than climate, but this too may be overcome by some adjustment for keeping the threshing part of the machine horizontal.

The criticisms made to-day against combines are surprisingly like those originally made against binders. If they surmount these criticisms, combines will achieve at least two important results :—

(1) Our farms will employ fewer permanent hands than at present, provided the general system is unaltered, a more serious consequence than the saving of merely casual labour. If the number of hands remains unaltered, some modification of the existing system (unless prices rise) will be necessary to increase the value of the total output of the farm. Failing this, combines may lead to further rural depopulation, and are therefore regarded with disfavour. But progress implies the fullest possible exploitation and development of mechanical aids and other improvements. The problem is to make them fit into our system with the greatest advantage to the community as a whole—very

easily written, very difficult to solve successfully. It is no solution to shut them out.

The total food production of this country, however, is not so high as to render it impossible to maintain the existing numbers on the land, even should their producing power be considerably increased by mechanical inventions. If, however, men should be displaced from farm work they might not necessarily be driven into the towns. Electrification might lead to the spread of industries and factories to the countryside. The rural population might change its vocation without migration.

(2) Combines will produce an indirect effect on these farms which, either because of size or position, cannot be adapted to the use of these machines. If they are unable to grow grain profitably, in competition with new methods, what adaptations or alterations in practice may be necessary to enable them to carry on successfully? A revision of land values and the reduction of rent might suffice to maintain the present system on these farms; corn-growing might be abandoned, the lack of litter changing the whole stock policy, or straw or other litter be imported from other districts; these farms might revert to little more than sheep runs, or temporary leys and sheep might still further increase; the losses on corn-growing might be paid for out of profits from livestock and potatoes; and so on. If straw is the important part of the corn crop, cannot the plant-breeder introduce a perennial straw-producer, or a crop yielding a satisfactory substitute? These thoughts lead to another much-discussed question—the idea of specialisation.

"**Specialisation.**"—It has been urged that farmers should reduce the number of different enterprises on their farms. Originally "specialisation" seemed practically synonymous with mechanised corn-growing. We are still apt to think of the latter as the wholesale importation of prairie methods with their low labour requirements and their low yields per acre. The Scottish farmer could never look favourably on this idea. This, however, does not condemn mechanised corn-growing when fitted into reasonably intensive systems such as exist in Scotland to-day. It is a question of adapting, not of adopting, prairie methods in this country.

The Scottish farmer is unlikely to agree to putting all his eggs in one basket. But the meaning of specialisation is really wider than that. It means that the farmer should concentrate on a few enterprises for which his farm is particularly suited and that each of these should stand on its own legs. In other words, he should not feed cattle at a loss to make dung so as to grow potatoes at a profit; or grow roots to feed sheep at a loss so as to grow malting barley at a profit. According to this definition, many Scottish farmers have been practising specialisation for years. But it is an important idea and is still capable of considerable development in practice.

So far, specialisation has been frequently taken to involve large-scale farming, e.g. four men, two tractors and their imple-

ments (and combine) farming 660 acres of grain on 1,000 acres of arable land. It is certainly better to farm land in England in this way than to leave it derelict, as much of it is to-day; but it cannot well be contemplated for Scotland. The size units in Scottish farming are fairly definitely fixed, the steadings made substantially so as to last for years. Better have multiple-farming than large-scale farming. Besides, the risks of disease amongst stock are too great if they are concentrated in large units. Better have several farms worked well and intensively by one able farmer than worked indifferently and with fewer and less efficient workers by a number of individual small farmers of less ability.

Crop Driers.—Returning to the use of the combine, its adoption, especially in Scotland, is likely to be successful only if the grain is put through a drier. (In most cases, too, extra storage accommodation would be necessary.) But the production of grain by this method would still cost less than under the existing system. After all, there is no reason why one combine and a drying plant should not be recognised as the standard equipment of a farm instead of two or three binders and a threshing machine as at present. The new equipment would probably involve little, if any, more capital outlay.

Moreover, when suitable and economic general-purpose drying plants can be produced commercially, the installation of crop-driers opens up further possibilities. Haymaking may be revolutionised. Young grass collected and dried makes a highly concentrated feeding stuff. Figures have been produced (they still need confirmation) to show that the yield, as measured by total feeding value, from one acre of young temporary or even permanent grass, suitably manured, and cut when about 6 inches high, is greater than from the same area of any other crop of normal size. Science has played its part in opening up this new possibility. It has now to be made an economic and practical proposition.

Another new possibility arises from the rapid growth—so far chiefly in England—of canning factories. They may quickly lead to new crops and the redistribution of the existing acreages of the various crops.

The Maintenance of Soil Fertility.—The costliness of labour has been one of the chief factors prompting suggestions for new methods. Grain-growing offers so many opportunities for saving labour that it has naturally received chief attention. In addition, many authorities still consider its profitableness the foundation of agricultural prosperity in England, if not in Scotland. It is worth considering the progress of the straw from the crop as grown to its return to the soil as dung. After cutting it is stooked, and possibly re-stooked; it may be pulled over to let the butts of the sheaves dry; it is forked on to a cart, built on the cart, forked off the cart, handled two or three times on the stack. At threshing it is again handled two or three times before going through the machine, and also when built into a straw

stack. From there it is again man-handled, generally at least twice, to convey it to yards or byres for litter. As dung it is forked into carts, removed from carts and finally spread. Naturally then, the handling and utilisation of straw bulk largely in all labour-saving suggestions. Is straw, in some form or other, necessary for the maintenance of fertility?

After combining, the straw may be burnt, or ploughed in, or collected into stacks and saved for litter, either loose or in bales. The idea that straw is an encumbrance—borne out by the suggestion to breed new cereal varieties with specially short straw—deserves careful consideration; but in most cases it will be rejected, and particularly in Scotland, so long as we grow potatoes and swedes and feed stock. On the Rothamsted wheat plots in Broadbalk, however, dung applied to the same strip annually (14 tons per acre) has resulted in no advantage in yield in comparison with certain mixtures of artificials. Also, several farmers have profitably grown grain more or less continuously for many years with the aid of artificials and without dung.

But the value of dung where roots are grown is beyond question, and its residual value is also great. A barley plot on which continuous applications of dung ceased over 70 years ago still yields obviously more, without any artificials, than its always-unmanured neighbour. On the light sandy soil of Woburn, on the other hand, there is a very much smaller residual value from applications of dung. Conceivably, straw ploughed in and supplemented with artificials may be as valuable as dung or nearly so, and an investigation to test this possibility is being conducted at present. This might remove the need for keeping stock at a loss merely to make dung, although the Adco process for artificially converting straw into manure has already removed that need, provided plenty of water is at hand. But there would have to be a very remarkable revolution in Scottish farming practice before the dung cart was eliminated.

The need for dung, however, can be, and is being, reduced. Potatoes are more frequently grown now after the ploughing up of a rich temporary ley. We have learned more about the value of out-wintering cattle, and, out-wintered, they save litter and manure the grassland (but we must remember the loss in value to dung lying exposed to the weather on the surface of the pasture). The understanding and use of artificial fertilisers is increasing. In addition, with the aid of tractor cultivation, it may be possible to increase, at least occasionally, the use of green manures; the value of different crops for this purpose is still being investigated, along with the factors necessary for their success.

Mechanisation of Present Practices.—If, as is understandable, the farmer would naturally hesitate to scrap a good range of equipment in order to start on quite new lines, he would probably support any development leading to the better mechanisation of existing methods which would result in a reduction of the labour and cost of handling a crop.

The mechanisation of the handling of dung seems the best way of solving the labour problem involved, at least in Scotland, under the present systems of stock-feeding. A practicable dung-loader and practicable dung-spreader would go far to achieving this object. The present type of dung-spreader is suitable if only it were much cheaper; it would be an advantage, too, if it could be convertible to other uses.

Tractors like the I.H.C. "Farmall" with special attachments for the cultivation of row crops may maintain swedes and turnips in their present place in Scottish agriculture.

A good mechanical potato lifter would be of great service in Scotland and would go far towards reducing the demand for casual labour.

It is not possible in an article of this nature to do more than indicate briefly some of the ideas current in certain agricultural quarters suggesting the possibility of the adoption of new methods; but every suggestion along such lines is being tested in England at present. Many of them, discussed at a recent conference held at Rothamsted, form the basis of this article.

Conclusions from English experience and trials cannot, however, be accepted wholly as applying to Scottish conditions, and the suggestion is put forward that similar investigations might well be profitably carried out in Scotland with the object of ascertaining the practical possibilities for changes in Scottish agricultural practice.

FLAVOUR IN MILK—I.

Professor R. H. Leitch, M.A., B.Sc., N.D.A., N.D.D.,
The West of Scotland Agricultural College.

A characteristic of milk which more than any other commends itself to the discriminating consumer is flavour. Whether or not the high food value of milk is realised by the general public, a fine flavoured milk is universally appreciated. But if the flavour is displeasing, the milk will not be acceptable, no matter how excellent its keeping properties, how rich it may be in butter fat or how low its bacterial content. The public does not understand fully the real significance of chemical analyses or of bacterial counts, but it does appreciate flavour. Indeed flavour controls all the other qualities of market milk, and it is a fact that milk is decisively rejected by the dealer or the consumer more often on account of a displeasing flavour than by reason of any other defect. An effective means of popularising milk would be to ensure that not only is it safe, rich and of good keeping qualities, but that it has a pleasing and attractive flavour.

In fresh milk of good quality, the sweetness is due to the milk sugar, and the aromatic taste to the butter fat. The flavour of

milk, however, while largely determined by these two components is also influenced by certain of the milk salts, particularly the chlorides. It has recently been shown that the taste (as distinct from flavour) of milk (1) is in large measure associated with the finely dispersed and easily dialysable components, and that when these are removed, the remainder of the milk is relatively tasteless.

Practically all the components of milk are subject to degradation changes which affect its flavour adversely—the fat by oxidation or cleavage, the casein and albumin by proteolysis, the milk sugar by fermentation, and the ash by exaltation of some of its components. But even when such flavour defects are well defined, the causal factor is often difficult to determine; and yet until the origin of the fault is known, advice such as might lead to its elimination or control cannot be offered. Defective flavours in milk may arise from physiological effects; from the incidence of bovine ailments or disease; from the food supply of the lactating animal; from the direct absorption of taints from the environment; from bacterial infection of the milk at the time of or subsequent to its withdrawal from the udder; or from the effects of oxidation during storage. In some instances, contact of the milk with certain metals may lead to the development of an off-flavour.

It should be observed at the outset that the sense of taste is not equally developed in all persons, and that a milk which is sensibly off-flavoured and displeasing to one individual may call forth no adverse comment from another. Defective flavours which will be discussed here are those which are sufficiently pronounced to be detected by the average citizen.

Physiological Effects.—The relationship of the physiological health of the cow to the flavour of the milk secreted is as yet little known. If the milk of individual cows in the same herd (all receiving the same food and the same general treatment) be critically examined by a person with a keen sense of taste, it will often be found that while the majority of the cows yield milk which is pleasing to the palate, some may give milk which has a flat and unattractive flavour. The milk of such cows if sold separately would be rejected by the fastidious consumer. Cases of this kind may happen with high grade milk bottled on the farm. If the milk of the individual cows is passed directly over the cooler to the bottling machine, occasional bottles may have a displeasing flavour. An examination of samples of milk of 536 cows supplying the University of California Farm Creamery revealed the fact that 68 (or 13 per cent.) of the cows, presumably in normal health, were producing milk which had an abnormal flavour. Roadhouse and Koestler (1) have observed a difference in the taste of the milk not only of individual cows in the same herd, but in different milkings of the same cow. The cause of such variation in the flavour of the milk of individual cows in full milk and in apparently normal health cannot be readily explained. It may have a physiological basis or it may be an

inherited characteristic. Relative work in America (2) would appear to show that the ability to produce a good flavoured milk is an individual characteristic, and one investigator foresees the time when whole herds of cows giving milk of an agreeable flavour will be assembled, and efforts made to perpetuate this desirable characteristic by breeding and selection.

Milk secreted by the cow at the very beginning and at the extreme end of the lactation differs normally from milk produced throughout the rest of the milking period. Colostrum with its bitter fleshy taste and its thick slimy consistency does not come within the category of market milk, because of its obviously abnormal character, but it is different with the milk of cows approaching the end of the lactation. After the ninth or tenth month, the milk sugar which hitherto has been maintained fairly constant begins to decline and at the same time the chloride of the ash increases in amount. The nett effect of this is that the milk acquires a rather sharp salty taste. Sometimes the milk of cows in advanced lactation is rancid and, when swallowed, produces a burning sensation in the back of the throat, the rancidity being due to the splitting of the butter fat by a lipase enzyme present in the milk. The rancidity usually develops in the milk within a few hours of its withdrawal from the cow. Sweetened condensed milk may also become rancid if through accident or error small amounts of such milk in the unheated state are made part of the batch. Rice (3) has found that as little as 0·3 per cent. milk containing lipase can induce rancidity in the condensed product.

A disturbed metabolic condition of the cow known in south-west Scotland as " staw " is responsible for a peculiar odour and flavour in milk. The milk as it is withdrawn from the udder has a strong penetrating smell suggesting a phenolic or medicinal odour; the taste is distinctive and disagreeable. Staw and its associated effects generally occur early in the lactation, usually about three to four weeks after calving. A change of feeding and careful veterinary treatment will usually rid the cow of this undesirable affliction.

A fishy flavour in milk apparently arising from a disturbed metabolic condition and recalling the effects of staw is reported by Harding, Rogers and Smith (4) to have occurred in the milk of an isolated cow in a dairy herd. The milk had a rank disagreeable odour and taste as though it had been in close proximity to herring or other fish. The fishy odour was easily detectable at milking and did not appear to increase on standing. There was no discernible ailment or lesion of the cow and the physical appearance of the milk was normal. The off-flavour could not be shown to be caused by any bacteria present in the milk, nor by the foods, which were fed alike to all the cows in the herd. Nor was it due to any objectionable weed at pasture.

A similar case of a fishy flavour in the milk of a cow kept for family use was reported by Griffiths in 1899 (*loc. cit.*).

Off-flavours perceptible in newly drawn milk are often due to

indigestion and dyspepsia in the cow. Experimental evidence shows that a prolonged and systematic deficiency of calcium and phosphorus in the food supply is also responsible for deterioration in the flavour of milk.

Pathological Effects.—Udder infections which are much more common than is generally supposed are perhaps the most common cause of unpleasant flavours in milk. Mammitis (garget) nearly always induces a disagreeable taste. Indeed whenever an off-flavour is encountered in the milk of any individual herd, a careful physical examination should immediately be made of the udders of all the producing cows. Such an examination may reveal an infected quarter in one or more cows, and if the pathological milk is withheld the troublesome flavour will usually disappear. It sometimes happens, however, that a clinical examination reveals no unusual feature; the udder may not be hard or painful; the physical appearance of the milk may be unaltered, and yet the milk is obviously bad flavoured. Such a circumstance is possible when one or more of the cows in the herd is suffering from a mild catarrh of the udder caused by micrococci.

While a "weedy" flavour is easy to recognise in the milk of individual cows, it is much more difficult to appreciate when the affected milk is mixed or diluted with a considerable volume of normal milk. The taste of the mixed milk may simply suggest a staleness, "something not quite right." Reference in such cases must be made to the milk of the individual cows.

Many professional investigators are averse to tasting such suspected milk because of the presence in it of pathogenic organisms, and hence the simple and effective method of locating the source of the offending flavour (i.e. in the milk of individual animals) is often neglected. Here, however, some guidance may be got from a microscopic examination of the milk, especially with reference to its leucocyte content. The presence of leucocytes in greatly increased numbers is suggestive of a derangement of the milk gland. Confirmatory evidence will be furnished by the alizarol test, by the catalase test or by the blood agar plate, and appropriate cultural methods will usually reveal the pathogenic organism. Even when a cow recovers from an attack of garget, the flavour of the milk from the quarter which was affected is inferior to that of the unaffected quarters; usually it is salty to the taste.

Peculiar odours occasionally accompany the disagreeable taste of "weedy" milk; sometimes the aroma suggests dough; sometimes it is fruitlike, suggesting pears.

Effect of Foods on Flavour of Milk.—The effect of specific foods on the flavour of milk and cream for butter-making has been frequently determined, but less attention has been given by experimenters to the effect of foods on the flavour of market milk. According to Kellner (5) foods which improve the taste of milk are good meadow grass, carrots, oats, rice meal. Hay of good quality and malt coombs would also appear to have a

beneficial effect. On the other hand, rape cake, on account of the frequent presence in it of mustard seeds, is a risky food, imparting as it often does an astringent and disagreeable taste, especially marked in the cream. On occasion, inferior samples of earthnut cake are productive of a rancid odour and taste. Mouldy cakes and meals are also unsafe to use, not only because they have an adverse effect on the flavour of the milk, but also because they prejudicially affect the health of the cow.

Flat unattractive flavours which occur frequently in milk in late winter and early spring are often the result of the long continued use of certain concentrates under stall fed conditions. One may quote here a typical instance of such an effect. A certified milk producer who by the excellence of his milk supply had built up a good market began to receive complaints from his customers about the flavour of his milk in the month of February. The milk had good keeping properties, its bacterial count was low, and such organisms as were present could not be shown to have any relationship to the flavour defect. No udder infection could be detected by clinical or pathological examination. The cows appeared to be in normal health, and the concentrates employed were standard market foods of apparently sound quality. There did not seem to be any readily explainable cause of the off-flavour. Whether or not a disturbed metabolic condition was operative, the following suggested procedure resulted in the elimination of the objectionable flavour.

To clear the bowel of any accumulated debris, the cows were each given a single administration of 2 lb. molasses and subsequently ½ lb. daily. Once a week 2 oz. flowers of sulphur were administered along with the treacle. The diet was radically altered; the substituted ration of concentrates consisted of equal parts of bran, oats and linseed cake. In addition a small amount of dried milk (½ to ¾ lb. per head) was given along with the concentrates. Straw was discontinued and a selected quality of hay was supplied. After a few days of this regime, the farmer reported that the undesirable flavour had completely disappeared and that the milk had regained its normal sweet and pleasant flavour. This procedure has been followed in several cases of a similar nature and has been attended with successful results.

The foregoing experience illustrates the fact that a ration may be productive, well balanced and economical and yet result in milk of an unattractive flavour.

Beet pulp, beet slices and beet tops are foods which are commonly believed to induce bad flavours in milk. On the Continent it has been found that beet tops may impart a putrid taste and smell to milk especially when the leaves are partly decomposed. Post (6) states that the offensive odour and taste of milk and butter, prevalent in the months of October and November in the beet growing districts of Holland where beet tops are used for cattle food, are due to tri-methylamine—obviously derived from betaine present in the food. Lucas (7)

confirms the experience of others that the feeding of sugar beet tops has a bad effect on the flavour of milk.

In south-west Scotland an off-flavour (sometimes reported to be oily and sometimes metallic) in milk has been attributed to the feeding of beet pulp. In the experiments conducted at the West of Scotland Agricultural College some years ago no harmful effect on the flavour of milk was observed, even when quantities amounting to 4 lb. per cow per day were supplied. Nevertheless the withdrawal of beet pulp from the ration in circumstances when an off-flavour is reported in the milk is experienced is said by many practical dairymen to be followed by an improvement in the taste of the milk.

The condition of the beet pulp is of some moment. Beet pulp of high acetic acid content has a tendency to cause digestive disturbances—a circumstance which may indirectly affect the flavour of the milk. Neutralization of the acid by the sulphate or carbonate of lime has been stated by American investigators (8) to be of some benefit in eliminating the harmful effects of the acid.

Silage is sometimes a source of trouble. In America, where it is principally made from the maize (corn) plant, silage is regarded as a palatable and wholesome food for dairy cows. Yet according to Lucas (7) a silage flavour is not uncommon in market milk, and in a survey made at the University of Illinois Experiment Station about 60 per cent. of the consumers preferred milk carrying a silage flavour. The investigations of the United States Department of Agriculture (2) have shown that flavour imparted by corn silage is either very materially reduced or altogether eliminated by feeding the silage after milking time. Silage which is supplied to the cows within an hour of milking is so quickly absorbed that its taint is discernible in the newly drawn milk.

Silage made from leguminous plants is much more liable to taint milk, and as a general rule it should be avoided in the feeding of dairy cows whose milk is sold for direct consumption. Alfalfa (lucerne) often produces a poor, ill smelling silage. Clover silage has a strong odour, and imparts a distinct food flavour to milk, even when as little as 5 lb. is fed daily.

Mouldy and decomposed silage is an unsafe food for cows, and when given in amounts from 5 to 15 lb. per head daily imparts a strong flavour and odour to milk, sometimes resembling garlic.

A silage flavour may be considerably diminished by effective aeration of the newly drawn milk.

The indiscriminate use of roots not infrequently leads to undesirable flavours and odours in milk. Turnips and swedes, supplied in large quantities, and especially when fed before milking, may cause a " turnip flavour " in milk. The taste is more pronounced if the turnips are partially rotted or have young secondary growth on the crowns. Cabbages may produce a similar effect, especially if slightly decayed. A turnip taste is

seldom observed if the roots are supplied after milking (or at least three to four hours in advance of milking time). As in the case of silage, aeration of the newly drawn milk reduces abnormal odours and flavours resulting from the feeding of turnips and cabbages.

Marrow Stem Kale, a cruciferous plant which in recent years has become popular with dairy farmers may, as Mattick and Mackintosh (9) have found, cause the milk to have a sickly flavour reminiscent of the crushed kale. The milk of some cows is more affected than that of others by the kale feeding, but the danger of getting a tainted milk is practically eliminated by feeding this foodstuff after milking.

The taint induced by the unskilful use of roots is more pronounced in cream than in milk, and for this reason a strong turnip flavour is not uncommon in farm-made butter during the winter months—when whole milk or raw cream is used as the primary material. The turnip taint is also a frequent source of trouble in New Zealand dairying.

The turnip taint is not simply an effect consequent on the feeding of roots; other factors appear to be involved. According to Orla Jensen (10) bacteria play a part in the development of the characteristic turnip flavour. The parent substance from which the taint is developed is a glucoside (present in cruciferous plants) which passes into the milk from the roots eaten by the cows. This glucoside is broken down by the action of certain liquefying bacteria which gain access to the milk, and which are derived either from fæcal contamination or from a polluted water supply. These facts emphasise the importance of clean milk production. A turnip taint is less frequently observed in clean high grade milk than in milk produced under less carefully controlled conditions.

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RECLAMATION AND CULTIVATION OF PEAT LAND IN LEWIS.—Part III.

W. G. OGG, M.A., B.Sc., Ph.D.,
Director, Macaulay Institute for Soil Research; and
ANGUS MACLEOD, B.Sc.,
North of Scotland College of Agriculture.

THE present article is the third of a series describing the progress of work on land improvement in Lewis financed by Mr. T. B. Macaulay of Montreal, and carried out by the Macaulay Institute for Soil Research, and the North of Scotland College of Agriculture.

The two previous contributions[1] dealt with the establishment of the Macaulay Demonstration Farm on Arnish Moor, near Stornoway; with the results obtained on the farm during 1929 and 1930; and with experiments on the improvement of pasture on land from which the peat had been skinned. Progress during 1931 will now be described and a brief account given of other schemes for the improvement of the crofting conditions and for the establishment of a poultry industry in the island.

Progress at the Demonstration Farm during 1931.—The area under crop has been nearly doubled and an additional area cultivated; some internal fencing has been carried out and a beginning made with the construction of farm roads. Road making on peat presents considerable difficulties, but an old wreck purchased from the Stornoway Harbour authorities for £5 provided much useful material.

It was found necessary to increase the building accommodation, and during the year a manager's house was erected; a Canadian tower silo of the wooden stave type and a poultry house were also added. The dairy and poultry stocks have been increased, a vegetable garden laid out, and additional experiments and demonstrations on grasses and pastures commenced.

Up to the present the character of the experiments has been more or less determined by the requirements of the farm. It was necessary to provide summer pasture and winter keep for the stock as quickly as possible, and much of the work has been of the immediate practical kind designed to meet these needs. The following table indicates the areas cultivated and cropped during the past three years :—

	1929. acres.	*1930.* acres.	*1931.* acres.
Rye and grass seeds	7·75	–	–
Oats	0·25	7·9	–
Oats or mashlum and grass seeds	0·3	5·4	17·0
Grass cut for hay	–	7·8	3·5
Pasture	–	–	10·0
Pasture improvement	–	2·0	14·5
Potatoes	0·6	1·75	1·75
Vegetables, &c.	0·1	0·25	0·75
	9·0	25·1	47·5

[1] *Scottish Journal of Agriculture*, vol. xiii, No. 2 (1930); vol. xiv, No. 2 (1931).

In addition, the following areas were cultivated but not cropped during the year :—

Experimental plots	2·0 acres.
Field cultivated with rotary cultivator ...	7·0 ,,
Fallow after oats	3·25 ,,
	12·25 acres.

The total area cultivated up to the present is therefore about 60 acres.

In cultivation and cropping two very different needs of the crofter have been kept in mind, viz. the reclamation and intensive cultivation of peat land, and the improvement of pasture at a small outlay.

The first public demonstration was held in August 1931, and was attended by over 200 people from all parts of Lewis.

Climatic Conditions during the year.—The rainfall for 1931 at Stornoway, three miles from the farm, was 46·97 inches, this being about 3 inches higher than in 1930 and 3 inches below the average. The wettest months were January (7·64 inches), February (6·97 inches), and December (5·69 inches). October and November had also fairly high rainfalls, about 5 inches. August (1·38 inches), March (1·53 inches) and September (1·66 inches) were the driest months. Spring (except during March) and the early part of summer were rather wet and this delayed cultivation and sowing, but there was some compensation in the fine weather of late summer and autumn.

Draining.—Practically all the drainage work on the farm was done by contract in the first half of 1929 and has been described in a previous paper. It was based on systems which have proved successful on the Continent, but in Lewis the results so far have not been satisfactory. This may not, however, be the fault of the system, and it is proposed to test it again by relaying the drains on a certain area, paying particular attention to direction and depth, to the opening in the wooden drainage box, and to the fixing of the boxes end to end to prevent displacement.

Drainage is one of the most expensive items in reclamation, and with a view to reducing the cost a test was carried out with a Henderson's "Universal" drainage plough, a new machine adapted for work in rough wet peat. The main features of the plough include a sledge carrying a central disc coulter and two side coulters to slit the centre and sides of the drain. The sledge is easily handled by a hand winch and thin wire rope so that the depth of the plough can be controlled. The winch is mounted above the girder axle, which joins stout broad-rimmed wheels placed 6 feet apart in order to avoid collision with the excavated peat. Behind the sledge is placed the main excavating unit, which is of interesting and ingenious construction. The forward end or spear point is a flattened torpedo of hard steel carried on the end

of a vertical knife, and flanked astern with two vertical sabre-shaped knives. As the machine moves forward the various knives cut away the contents of the drain in two vertical slices, which glide rearwards and outwards to the surface. The ditch is excavated at one movement of the machine.

At the farm excellent results were obtained with this implement, and it was shown to be capable of cutting a drain 20 inches deep, 2 feet wide at the surface and one foot wide at the bottom, at a rate of 150 yards in three minutes, and at a cost estimated at a fraction of a penny per yard. The machine is also capable of cutting deeper drains and gives promise of being very useful in reclamation work.

In the last article describing the work on the farm in 1930 it was mentioned that the growth of a good sole of grass very perceptibly dries the moor. Since much of the moorland in Lewis has a fairly good slope, it has been suggested that in certain places under-drainage of such land is unnecessary for pasture, as much of the rainfall will run off the surface. This point is being carefully studied.

Cultivation.—An additional area of about 15 acres of moorland was brought under cultivation during the year. The portions which were sufficiently level and not too soft were cultivated by means of the "Lanz" rotary tiller. Under suitable conditions this machine is very satisfactory, but much of the peat land in Lewis is too soft and too rough to give good results, and further experiments on the cultivation of such land have been carried out.

An implement which seems to promise well is a rotary spade harrow of a type used in Finland, Sweden, and certain parts of Germany. In this harrow there are several cross bars carrying knives arranged like a series of four-bladed propellers, which revolve as the implement is dragged along. It is weighted down, and the blades dig into the peat and cut it up. It is possible by going over the ground twice or three times to produce a surface suitable for sowing grass seeds. This implement may be dragged by means of horses where the ground is sufficiently firm, but on the farm the caterpillar tractor was used, and in this way it was possible to prepare for seeding areas of land on which the big rotary cultivator or the moor plough could not be employed.

The rotary harrow may also prove useful in the improvement of heath land, and of land from which the peat has been skinned.

Cropping.—The area on which most of the cropping work has been done lies in the central part of the farm (shown on the plan between two projected farm roads, with the main ditch running through it). On the south side of the main ditch is an area of deep wet peat with a gentle northerly slope; on the north side of the ditch the peat is thinner and drier, and the slope is towards the south. Practically the whole of this area has been cultivated and a good deal of it cropped. The portion of the farm north of this central area consists of thin peat with occasional rock outcrops in places. The present intention is to

utilise the centre part as arable land, and to improve the strips to the north and south for grazing.

Hay.—An area of 3·4 acres under mashlum in 1930 was cut for hay in 1931. The crop varied considerably, but the best portions compared favourably with hay on good mineral soil, and was very free from weeds. It would appear that when this type of moorland is cultivated and the manuring done with artificial manures (thus avoiding the introduction of weed seeds), the native vegetation, at any rate for the first year or two, does not reappear, and the crops are remarkably clean. The yield of hay was about 2½ to 3 tons, and a second crop was obtained from part of the field and fed green to the stock.

Pasture.—Two different schemes are being tried for the production of pasture. In the first, the usual procedure for the production of good pasture on mineral soil is being followed, viz. thorough cultivation, fairly liberal liming and manuring, and a good grass seed mixture. Since there are great areas of land in Lewis of very low value, at present supporting a sparse and almost worthless native vegetation, it was considered desirable to try a second scheme and attempt the improvement of this land at the lowest possible cost.

The first of these two schemes has been carried out in Field 6. As described in Parts I and II of this series of papers, 7¾ acres of this field were drained (where draining was needed), cultivated by means of the "Lanz" rotary tiller, and uniformly dressed with artificial manures. In July 1929 this area was sown with rye and five different grass seed mixtures, and cross-dressed with different amounts of lime and shell sand.

An additional area of just over two acres received a dressing of shell sand, a smaller amount of artificial manures, and was sown out with oats and a grass seed mixture in 1930.[1]

The whole field was grazed in 1931 and provided excellent pasture for the stock, which consisted of four cows, two heifers and a young bull. As a separate paper dealing with the pasture on this field will be published in the next issue of this JOURNAL, it is unnecessary to give any details here.

The only unsatisfactory areas were a few wet places on the level ground, a few spots which had been missed by the cultivator, and the "no lime" plot at the east end of the field, which has deteriorated very rapidly.

Pasture Improvement.—The second of the pasture schemes referred to above, viz. pasture improvement at a low cost, was begun in 1930 on a 2-acre plot to the north of Field 6. At Mr. T. B. Macaulay's suggestion, two composts were used for manuring, the chief ingredients of which are abundant in Lewis. One was made from peat, seaweed, herring offal, basic slag and a small quantity of farmyard manure; the other contained no herring offal, but received nitrate of soda in addition to the materials already mentioned. The amounts of nitrogen and

[1] "Reclamation and Cultivation of Peat Land in Lewis," Part II, *Scottish Journal of Agriculture*, vol. xiv, No. 2 (1931).

phosphoric acid were calculated to give the equivalent of 1 cwt. sulphate of ammonia and 4 cwt. slag per acre in each case, in addition to the farmyard manure, seaweed and peat used. The composts were prepared in November 1929 and applied in April 1930, one acre being treated with each compost. At the same time a mixture of grass and clover seeds was sown, and the whole area was harrowed with an ordinary spike harrow. The weather was unusually dry at the time of sowing and germination was irregular, but in spite of a bad start the grasses and clovers have become established on the peat and a marked improvement has been effected.

Up to the present no appreciable difference between the effect of the two composts on the pasture has been noticed.

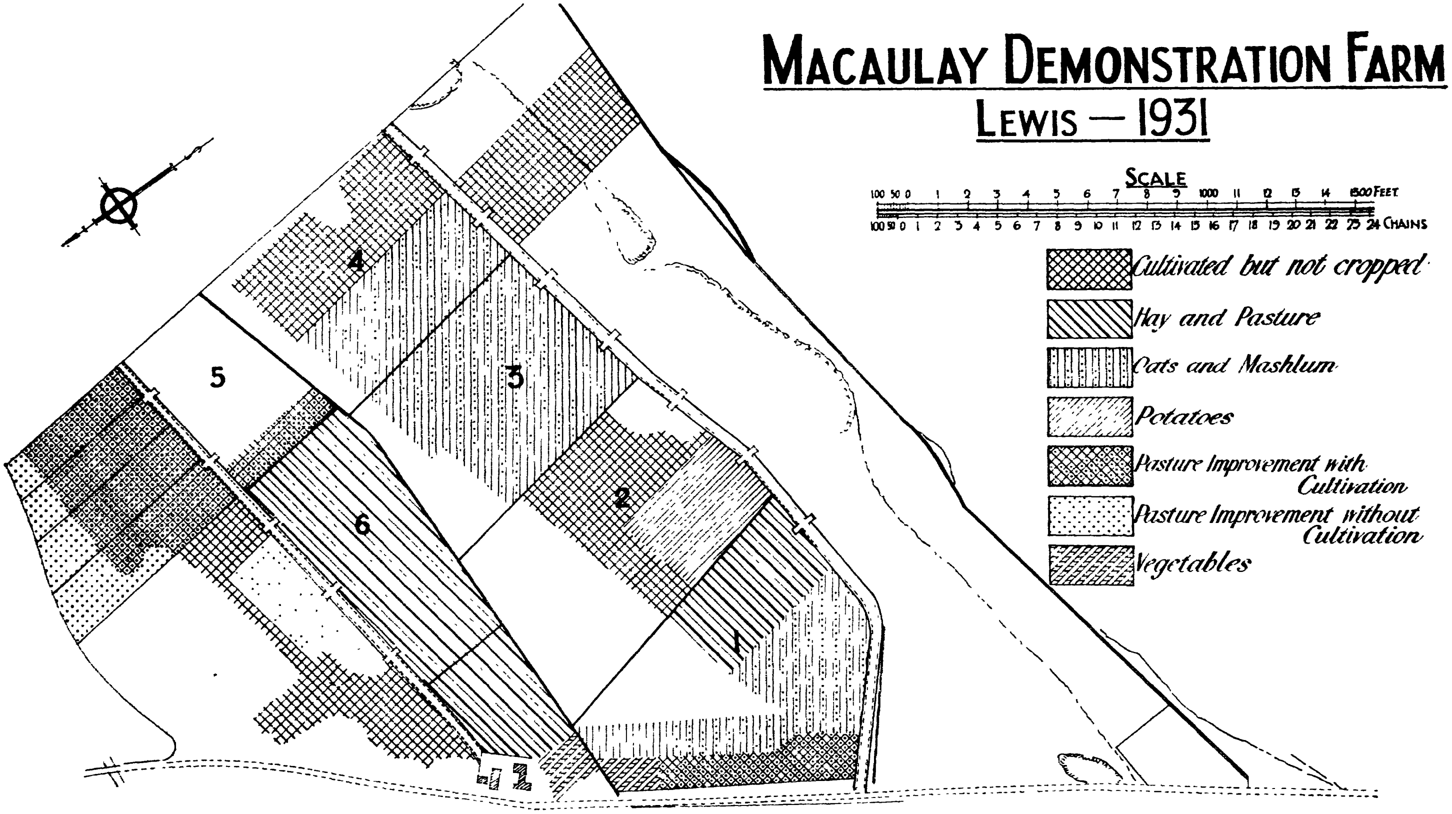
In the experiment just described the land received no cultivation except a scratching of the surface with harrows. A further series of experiments on pasture improvement was laid out on the northern section of the farm in the autumn of 1931, and in this case some of the land was cultivated with the "Lanz" rotary tiller. Part of the area was rough and other parts contained rock outcrops or peat cuttings, and in these places cultivation was not attempted. By means of these different series of experiments it will be possible to compare cultivated areas with those which received no cultivation. The manure used was a mixture containing fish refuse from the Stornoway fish guano factory (containing about 7 per cent. nitrogen and purchased at £2 per ton), superphosphate and potash salts. Various grass seed mixtures were sown on strips running parallel to the eastern fence of the northern section of the farm, and details of these experiments will be given at a future date.

An acre of Field 5 was cultivated and sown out with a seed mixture consisting of 40 lb. ryegrass cleanings and 4 lb. wild white clover cleanings. This also was manured with fish refuse, potash salts and superphosphate, the total cost of manuring and seeding being less than 30*s*.

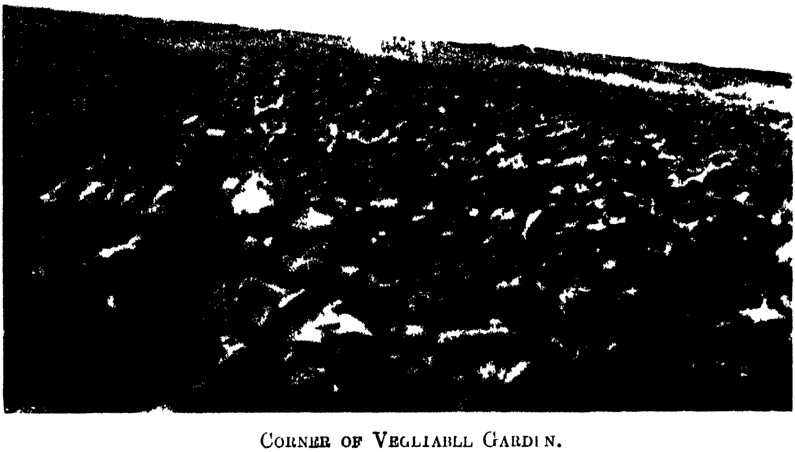
It is particularly important to attempt the improvement of the poor and very extensive common grazings in Lewis, and if this improvement is to be carried out by the crofters it is essential that it be done at a low cost. Very cheap seed mixtures have therefore been tried and the costs have been kept down in every direction.

Part of the north section of the farm (about 2·5 acres) has been fenced off and cultivated with the rotary tiller. Some of this area has been laid out in plots of individual grasses, clovers and other pasture plants.

Oats and Mashlum.—These crops were grown on Fields 1, 3 and 4, where the peat is deep and very wet. Four varieties of Garton's Winter Oats, viz. "Marvellous," "Grey Winter," "Bountiful" and "Black Winter," were tried on Field 3, an acre of each variety being sown on 22nd October 1930. The crop brairded well, but on account of unsatisfactory drainage the field was badly flooded for some time afterwards, and much harm


MACAULAY DEMONSTRATION FARM
LEWIS — 1931
SCALE
100 50 0 1 2 3 4 5 6 7 8 9 1000 11 12 13 14 1500 FEET
100 50 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 CHAINS
Cultivated but not cropped
Hay and Pasture
Oats and Mashlum
Potatoes
Pasture Improvement with Cultivation
Pasture Improvement without Cultivation
Vegetables
1
2
3
4
5
6

MACAULAY DEMONSTRATION FARM.



CORNER OF VEGETABLE GARDEN.

HENDERSON'S DRAINAGE PLOUGH

The Potato Crop, showing method adopted on the wet Peat

was done to the young plants. A satisfactory comparison of the varieties was impossible under these conditions, but "Marvellous" appeared to be the best, producing good grain and strong straw. The whole crop was much too thin, but the results indicate that in Lewis, with its absence of frosts, winter oats may be grown satisfactorily.

Towards the end of April the first spring oats were sown on about five acres of the west side of Field 4. The seeding per acre consisted of 4½ bushels of oats, 20 lb. of Italian rye grass, 4½ lb. of alsike, and 2 lb. of broad leaved red clover. The manurial dressing was 3 cwt. fish refuse, 2 cwt. superphosphate, 1 cwt. potash salts and ½ cwt. sulphate of ammonia per acre. The crop, which did very well, was cut for silage about the end of August.

Sandy oats at the rate of 5½ bushels per acre were sown on the east half of Field 3, three weeks later than the oats on Field 4, and the same manurial dressing applied. This crop was backward for some time, but the tillering was good and the crop made very satisfactory progress later. It was not as heavy as the earlier sown crop, and probably would not have ripened evenly, but it was required for silage and was cut green.

Two grass seed mixtures were also sown on Field 3.

About three acres in Field 1 were sown with the same mixture as was used in Field 4, viz. oats, Italian rye grass, alsike and red clover. It was rather late in June before this was done, and with the exception of a small area mentioned below, the crop of oats was poor. The grasses and clovers, however, came up well and provided good grazing for the young stock up to the end of the year.

The exception mentioned above was an area of about one acre which was too soft to be cultivated by means of the "Lanz" rotary tiller. The rotary spade harrow was therefore used, and the oats did quite well, so that the failure on the rest of the area may have been due to unsatisfactory tilth. Compared with the previous year, the oats and mashlum crops gave rather lower yields, and this has been attributed to the smaller dressings of manures.

Potatoes.—On account of the difficulties in making drills on the soft wet peat land, an attempt was made in 1930 to grow potatoes without drills by dibbling on the level, but without success.[1] In 1931 another method was tried. An area of about two acres on Field 1, which had been liberally manured when under oats in 1930, was selected. The following manurial dressings were applied :—

Sulphate of ammonia	... ...	1 cwt. per acre.
Superphosphate	... ...	2 ,, ,,
Potash salts	... ...	1½ ,, ,,
Herring offal	... ...	3 ,, ,,

[1] "Reclamation and Cultivation of Peat Land in Lewis," Part II, *Scottish Journal of Agriculture*, vol. xiv, No. 2 (1931).

Part of the area received, in addition, a moderate dressing of farmyard manure.

The German mouldboard moor plough, which has already been described,[1] was altered in such a way as to make a furrow 3 to 6 inches deep and 16 inches wide, and with this implement alternate furrows were ploughed, the inverted furrow slices being turned over on top of the adjoining undisturbed strips between the furrows. The result was a series of rather wide ridges. The seed potatoes were dibbled through the inverted furrow slices (the top of the ridges), and lay between the surface of the undisturbed strip and the inverted surface of the upturned slice, both surfaces consisting of mossy stubble which had been well manured. The holes into which the sets were dibbled were filled with sand.

The potatoes, which were planted on 23rd May, grew fairly well, and gave a yield of approximately 2½ tons per acre. Three varieties, viz. Kerr's Pink, Great Scot and Duke of York, were grown; in every case the quality was good and the crop sold readily at from 8*s*. to 9*s*. per cwt.

The possibilities of this method of cultivation must not be judged by the yields obtained in the above experiment. The plough was not quite suitable for the purpose, and a good deal of the ground was wasted in experimenting with it; the furrows too were uneven in thickness and in width apart. A high yield per acre could not be expected, as the ridges are necessarily rather wide and far apart, but the method may have its uses during the process of reclamation, since it offers possibilities of growing a moderate crop of potatoes on badly drained peat land.

Vegetables.—The results obtained in 1929 and 1930 indicated that further drainage of the garden was desirable, and in 1931 open drains 15 feet apart were made. The land was manured with fish guano, and certain portions also received farmyard manure and shell sand.

A wide range of vegetables was tried, and most of them were successful in spite of the raw nature of the peat. Lettuce, celery, kale, cabbage and cauliflower grew particularly well, and radish and leeks were also good. Carrots and turnips did well in the early stages of growth but remained small, probably owing to insufficient drainage and lack of deep cultivation. Beans also made a good start but failed later, and from their appearance a potash deficiency was suspected. Peas were fair, and with more cultivation and drainage should do better. Savoys were fair. Beetroots, parsnips, parsley and spinach started well, but these crops were unfortunately damaged by animals.

The year's results from the garden were distinctly encouraging, and as decomposition of the peat proceeds, still more satisfactory results may be anticipated.

Dairying.—Various breeds of cows are being tried with a view to testing their suitability for the climate and other conditions in the island. As a rule winter feed on the crofts is

[1] *Scottish Journal of Agriculture*, vol. xiv, No. 2 (1931).

scarce, and even the summer pasture is often poor. A breed which may do well under the best conditions of feeding and housing, therefore, may not be the most suitable for Lewis as a whole, and in many parts of the island milk production is not the only consideration.

The first cows purchased were Red Polls, and recently three Ayrshire Shorthorn Crosses and two pure-bred Friesians have been bought. They are being fed on hay and silage produced on the farm, supplemented by purchased hay and concentrates. Tests which have been carried out show that the milk is well above the "certified" standards, and it is being sold in sealed bottles in the town of Stornoway. It is also encouraging to find that since the establishment of the demonstration farm one of the few dairy farms on the island has obtained a Grade A (T.T.) Certificate, and is now supplying the local sanatorium and hospital.

Poultry Schemes.—The poultry work at the farm was commenced in 1930 with a 12-bird breeding unit, and in 1931 an intensive 100-bird house was erected and the stock increased to 90. The breed selected for the poultry development schemes in the island was Rhode Island Red, and during the year a large number of sittings of eggs was distributed.

This work at the farm forms part of a larger scheme for the development of the poultry industry in Lewis, described in another section.

Trees and Shrubs.—A belt of Sitka Spruce and Mountain Pine planted along the roadside south of the farm buildings in 1929 has made fairly good growth, and most of the trees are thriving. They were planted on upturned turves and some basic slag was applied at the time of planting.

A belt planted in a similar way to the north of the buildings in 1931 is also making satisfactory progress.

The osiers in the south-west corner of the farm have made very slow growth, and the rhododendrons have done well only where the drainage was good. A Cotoneaster hedge is growing well, and other hedge plants, various shrubs and two varieties of hazel are being tried.

Experiments on Skinned Land.—*No.* 1.—The experiment begun in 1929 was continued in 1931, when the plots were again cut for hay. As described in two previous articles [1] a portion of skinned land was fenced off and divided into four sections, the first of which was trenched, the second lightly dug, the third roughly levelled and the fourth left uncultivated. The whole area was seeded in May 1929 with a grass and clover seed mixture (the trenched and dug strips being sown with oats as a nurse crop), and was cross-dressed in strips with various dressings of lime and manures. The plots were also cut for hay in 1930, and with the exception of one previously untreated plot, which received a dressing of 8 cwt. of slag in the autumn

[1] *Scottish Journal of Agriculture*, vol. xiii, No. 2 (1930), p. 131; vol. xiv, No. 2 (1931), p. 138.

of 1930, the plots have not been treated in any way since they were laid down.

The yields of hay from most of the plots were much lighter in 1931 than in 1930, as was to be expected since the plots were not re-manured. The highest yields ranged from about a ton to 25 cwt. per acre (calculated from the small plots), as compared with approximately 2 to 4½ tons in 1930.

The roughly levelled and uncultivated strips in 1931 produced a crop too short for cutting, but on the plots which received lime or shell sand plus manures there was a very satisfactory growth of clover (alsike and wild white in particular) and some of the sown grasses, especially on the plots which received organic manures (seaweed or farmyard manure) in addition to artificials. On the plots which received manure but no lime the grasses were of a rough inferior type, the sown grasses and clovers being practically absent.

The good effects of cultivation continued to be very noticeable, and it was observed that the trenched plots gave a better quality of hay than the lightly dug plots.

Cultivation alone produced no result, and the plots which received shell sand but no manure were very little better than the untreated plots, except for a slight increase in the amount of clover.

The different quantities of manures applied gave rise to striking differences in yields. Certain plots received only half as much fertilisers as others, and produced much lower yields—in some cases half the yields—of hay. There were indications that it is advantageous to apply the phosphate in the form of basic slag, and the good yield (over a ton per acre) obtained from the plot which received slag in the autumn of 1930 suggests that the application of slag alone will effect a marked improvement on this type of land.

No. 2.—With a view to studying more fully the manurial requirements of this type of land, ten additional plots (in duplicate) were laid down in September 1930. The advantage of liming was obvious from the results of the first experiment, and shell sand was therefore applied at the rate of 4 tons per acre to all the plots. The whole area was dug with a spade to a depth of 4 inches (with the exception of one plot where the seeds and manures were applied without any cultivation), and a comparatively cheap grass and clover seed mixture was sown.

The treatments were as follows :—

Plot.	*Manurial treatment per acre.*
1.	1 cwt. sulphate of ammonia. 4 cwt. superphosphate. 1½ cwt. muriate of potash.
2.	No manure.
3.	As No. 1 but no cultivation.
4.	As No. 1 but no phosphate.
5.	As No. 1 but no potash.

Plot.	*Manurial treatment per acre.*
6.	As No. 1 but no nitrogen.
7.	8 cwt. ground mineral phosphate.
8.	8 cwt. slag.
9.	8 cwt. superphosphate.
10.	2 tons fresh herring offal [1] and 4 cwt. ground mineral phosphate.

The plots were cut for hay in the autumn, and yields amounting to a few cwt. per acre (calculated from the small plots) were obtained from all the plots with the exception of 2, 3 and 4.

It is still too early to draw conclusions from this experiment, but the results serve to emphasise still further the importance of phosphates in the improvement of this type of land. In the absence of phosphates, potash and nitrogen gave practically no result, and according to the preliminary results nitrogen had little effect. It is possible, however, that the heavy rains in winter washed some of the manure off the plots. The effect of phosphates alone was noteworthy, and it was evident that the plots which were manured and seeded without cultivation were considerably improved although the crop was not long enough for cutting.

Poultry Development Scheme.—In 1930 Mr. Macaulay provided 16 poultry breeding units, which were given, under certain conditions, to four selected crofters in four different districts. In addition, each of these crofters was supplied with six pullets and a cockerel of the Rhode Island Red breed. In return the recipients undertook to follow the instructions of the county instructress of the North of Scotland College of Agriculture in the management of their poultry, and to supply sittings of eggs to other crofters at an agreed price.

Mr. Macaulay also offered to present the materials for the erection of a poultry house and run to every crofter in these four districts who reared a certain number of pure Rhode Island Red pullets in 1931, on condition that the houses were erected and the poultry managed to the satisfaction of the county instructress.

As a result of this scheme over 200 sittings of eggs were distributed in 1931, and 40 crofters qualified for the gift of materials, making a total of 56. The grading and marketing of the eggs from these pure-bred stocks are also being carried out under supervision of the county instructress, and this work will be continued until there is a sufficient number of crofters in the scheme to form a co-operative society. The progress already made has given a much needed stimulus to poultry keeping throughout the whole island.

Scheme of Prizes for Crofters.—In order to supplement the work of the demonstration farm, and to encourage crofters to put reclamation and land improvement into practice on their own holdings, Mr. Macaulay inaugurated a scheme of prizes in

[1] Most of the herring offal was eaten by gulls.

1929. There are over 3,000 crofts in the island and money prizes are awarded annually in the various districts for :—

(*a*) the best managed crofts,
(*b*) the best pieces of reclaimed land,
(*c*) the best managed pure-bred poultry stocks,
(*d*) the best vegetable crops,
(*e*) the best crops of early potatoes.

The value of the prizes was increased from £157 in 1929 to £295 in 1931, and the interest taken in the competitions may be judged by the fact that the number of competitors increased from 258 in 1929 to 535 in 1931.

In most districts crofters have entered the competitions with great enthusiasm, and it is very evident that increased attention is being given to the management of the crofts. The land already under cultivation is being improved, more is being reclaimed, and the growing of vegetables and early potatoes is being taken up throughout the island.

INSECT PESTS.—No. XIV.

R. STEWART MACDOUGALL, M.A., D.Sc.

THE TWO-WINGED FLY ENEMIES OF CEREALS.

THE damage with these Dipterous enemies is done by the larva or maggot. Omitting the Tipulid or Daddy Long Legs larvæ,[1] which are large, easily seen by the naked eye, and which feed externally, we give, in the following tabular key, a note of different species of larvæ that are minute in size and feed, not exposed, but some in the very heart of the young plant and others under cover of the leaf-sheaths or in the flowering parts hidden by the glumes and bracts or scale leaves.

Wheat.

Hessian Fly.—Larva pale reddish when young; later white. Larva feeds in summer between the leaf sheath and the young stem; the first and second internodes are the favourite places; the stem at the place of attack becomes elbowed from weakening due to drainage of sap, and the ears are poor. Pupation at feeding place. (Sometimes barley is attacked. Couch grass is a natural host.)

Haplodiplosis equestris.—Larva very minute and red in colour; larvæ feed under cover of leaf-sheath, giving rise to cushion-like swellings in a line down the young shoot, each swelling holding a larva. The full-fed larva falls away from the plant for pupation.

[1] *Journal of Department of Agriculture for Scotland*, January 1932.

The Wheat Midge (Contarinia tritici).—Larva golden yellow; found in the flower-heads; grain poor or none.

Wheat Bulb Fly.—Larva feeds in the heart of the young plant between the roots and the ground level; causes yellow discoloration of central leaves and crop failure in May or April; larva, the largest of any insects in the table, measures two-fifths inch in length when full grown; of the fleshy projections round the end joint of the body two in the middle line are larger than the others and both are forked at their apex.

Oats.

Frit Fly.—Larva an enemy of spring-sown oats; lives in heart of young plant, destroying the shoot. A symptom is the yellow discoloration of the young central leaf in late spring or early summer; larva minute, yellowish, with two rounded projections at hind end of body. The second brood of flies in summer lays eggs in the flowers inside the glumes, the larvæ spoiling the developing grain.

Barley.

Gout Fly.—The larva in June, from eggs laid on the leaves, eats its way down the shoot, tunnelling down one side of the ear and spoiling the developing grains on that side; the shoot is stunted, the ear may not escape from the cover of the sheathing leaves, and a swollen or gouty appearance is the result; larva pale yellowish sometimes with a trace of green; tapering more in front than behind and reaching one-fifth inch in length. The larvæ of the August brood are found mostly in couch grass in which they pass the winter (rarely on wheat and barley).

The species in this table or key were described in the JOURNAL for October 1931 except for the Wheat Bulb Fly, the Frit Fly and the Gout Fly.

The Wheat Bulb Fly (*Leptohylemyia coarctata*).—This fly is a serious enemy of young wheat; the larvæ also use winter barley and couch grass as hosts. Periodical outbreaks of this species in Scotland and England may be attended with a high percentage of crop failure. The features of great importance in the life-history of the Wheat Bulb Fly are :—

(1) *The eggs are laid in late summer and early autumn on uncovered land*, i.e. land bare of a crop, or where the crop from its habit of growth or the conditions of its cultivation is not dense enough to shade the soil.

(2) The eggs remain for a long time unhatched and unharmed by culture operations.

(3) The nature of the weather, especially in late July and August when egglaying is at its height. In this connection Mr. F. Hiam, one of the largest fen farmers—the fen district is an area that frequently suffers from Wheat Bulb Fly attack—wrote to Mr. F. R. Petherbridge,

Cambridge [1] :—" The Wheat Bulb Fly is not likely to be the cause of much harm in a season following a wet, cold or damp summer, but during a dry summer, say from 20th July to the end of September, on all bare lands where there is not sufficient top to keep the sun from the land, the Bulb Fly will deposit her eggs, and if wheat is sown it is sure to be spoilt when the eggs hatch in the spring. On wet lands or in a wet season the eggs do not seem to mature."

As regards the nature of the crop preceding the wheat crop, reports from all centres of damage have proved that damage is worst where, for any reason, according to the farm rotations of different parts of Scotland and England, there is uncovered land during the latter part of the summer, such environment being chosen by the flies for the placing of their eggs. A general summary from my notes would be :—" Worst after bare fallow; worse after potatoes than after turnips; worse after early potatoes than late; harmful even with late potatoes if they have not reached, by early July, a dense enough stage of growth." The late Professor Gemmill wrote [2] :—" The parts of a field worst damaged are usually those in which the shaws of the previous year's potatoes left much bare ground between them, or withered early, or were early dug up."

Life-history and Habits of the Fly.—For a long time the flies and their maggots and their pupal cases have been known to entomologists, but till comparatively recently the year's round of life of the Wheat Bulb Fly has been uncertain. There was uncertainty about the eggs, and how and where and in what stage or stages the insect spent the period, from the issue of the adult flies in summer until the appearance of the larva in the next early spring, in the young winter wheat. We now know that this interval is spent in the egg stage in the soil. Gemmill [3] was the first worker to recover the eggs from bare soil and in potato fields, and Petherbridge [4] watched and described the laying of the eggs in soil provided experimentally in the laboratory. The fact that the eggs were laid in bare soil had been suspected for some time. Gemmill stated [5] that the eggs of the Wheat Bulb Fly in the soil remained undamaged by heavy roller pressure, and that they withstood the action of strong brine, copper sulphate and picric acid.

The Wheat Bulb Fly belongs to the family *Anthomyidæ*. It is a two-fifth inch long grey-yellow fly, hairy and bristly. The flies come away in June and July from the pupal cases in the soil. After feeding for a short time, mating takes place and the

[1] "Observations on the Life history of the Wheat Bulb Fly." *Journal of Agricultural Science*, vol. xi, Part I.

[2] *Journal of Department of Agriculture for Scotland*, vol. vi, No. 2.

[3] *Nature*, Sept. 30, 1920.

[4] Observations on the Life history of the Wheat Bulb Fly," by F. R. Petherbridge. *Journal of Agricultural Science*, vol. xi, Part I

[5] "Wheat Bulb Disease," by Professor James F. Gemmill. *Scottish Journal of Agriculture*, April 1923.

fertilised females proceed to their egg-laying. Petherbridge, experimenting with flies bred out in the laboratory, placed them in a jar that held, in the bottom, sifted soil. The females were watched and they laid their eggs, "the ovipositor being inserted to its full length in the soil." In another experiment where sterilised soil was used, one part was left bare, one part had transplanted ryegrass in it, and the remaining central portion was sown with wheat. The females laid eggs on the bare fallow and in the loose soil between the wheat plants.

Egg-laying continues from June to September. The eggs—white and elongated, with one side rounded and the other concave—may not hatch until the following February. With such an extended period over which eggs can be laid, there can be differences in the time of hatching, e.g. I have taken Wheat Bulb Fly larvæ from dying young wheat plants in the months of November and December, the specimens having been sent to me from England. On hatching the maggot makes its way into the young wheat plant and feeds in the heart of the young plant between the roots and the ground level. To find the larva one should remove the leaves from outside inwards one after another. The part actually attacked by the maggot, in its feeding, is the succulent growing region immediately above the little swellings that give rise to the early leaves. The larva may feed in this growing point of the main shoot or of a tiller. A symptom of attack is the yellow discoloration of the central leaves. Attacked plants may die away and a considerable mortality may take place before the mischief is noticed.

The destruction of the young wheat plants is sometimes ascribed to wireworm, but a little observation soon enables the farmer to distinguish between wireworm damage and Wheat Bulb Fly damage. In the case of Wheat Bulb Fly attack the damage is in the centre of the young plants, and in these plants, while the central leaves may be discoloured and withering, the outer leaves may still be green; while "the characteristic sign of wireworm attack is that not only the central leaf but also one or more of the outer leaves of a shoot or a tiller turns yellow, since the wireworm, in burrowing into a plant, bites through the base of the outer leaves before reaching the centre. A further indication of wireworm attack is that four to five consecutive plants in the row are killed, while Wheat Bulb Fly attack is usually more scattered." [1]

In Scotland the maggots can be found in the wheat from February till May. Examination at the later period will show that many of the larvæ had completed their growth and left the plants. The farmer will find, in an average season, that the likely time for attack to be at its worst is from the last week of March to the middle of April.

The maggot when full grown leaves the plant and enters the soil, where it pupates under cover of the last moulted skin of the

[1] "The Wheat Bulb Fly in Collected Leaflets on Insect Pests of Farm and Garden Crops." Ministry of Agriculture and Fisheries.

maggot; this skin becomes hard and dry and forms the brown-black pupal case.

The full-grown maggot measures, when extended, two-fifths of an inch, or just over this, in length. It looks very like other species of small fly larvæ with its pointed head end, its dark horny mouth-hooks, its blunt, thicker, hind end; but round the edge of the last joint are nine small projections, of which two in the middle line of the under surface are not only larger than the others but are forked or two-pronged at the tip.

Plants attacked by the larvæ.—The oat is immune. Barley escapes not because the larvæ refuse it but because with us the larvæ have completed their growth before the barley is ready. Petherbridge and Morris in England found the larvæ in winter barley and in winter rye. In the fields Gemmill took the larvæ in couch grass, and in winter rye after potatoes; and in the laboratory he found that larvæ removed from wheat would enter couch grass and barley and rye and in these complete their growth. Graminaceous plants only are attacked; crucifers and legumes and potatoes and mangolds are all immune.

Control.—The farmer should not, in a good growing season, be in a hurry to plough up his young wheat because in March the field looks disheartening. I have known surprise yields to follow in fields that seemed in early spring to offer little hope of a crop. If sowing has been early enough the plants may be strong, and there can be compensation from tillering.

There is no vulnerable stage in the life-history of the Wheat Bulb Fly where insecticides can be used.

In considering the possibility of a cultural method of controlling this insect here is a suggested solution, roundabout perhaps, but able to stand the test of criticism. It is agreed of course that apart from Wheat Bulb Fly the best place in the rotation for wheat is after potatoes, but in a district where year after year the Wheat Bulb Fly may be expected some scheme like the following might be attempted :—

" The eggs are laid in July and August, preferably on bare soil, or on soil with a very light cover, and the pest is observed to be most destructive when bare land is exposed at the time. The method of control indicated is, therefore, to keep the land covered as far as possible in the summer before wheat is sown. For many considerations, including conservation of manures and economic manuring, wheat is the most suitable crop to follow potatoes on land where these two crops are grown. Wheat after maincrop potatoes is observed to be little affected by the Wheat Bulb Fly, as one would expect from the fact that the ground is well covered till after August. After Early maincrop and 2nd Early and Early varieties (especially the last), attack by the pest is more common and destructive. The control measures may thus take two directions: I. the growing of a catch crop between the potatoes and the wheat; and II. altering the rotation.

" *I. Catch Crops.*—After Early and 2nd Early potatoes a

catch crop should invariably be grown where possible, not only for the purpose of controlling the pest, but from other considerations altogether; the crop may either be eaten or ploughed in. The limits to this method of control, however, are greater than would appear, as, in the first place, most good Early potato land is not wheat land; and secondly, in wheat lands where Early potatoes are grown the question of conservation of moisture may often make a luxuriant leafy catch crop such as follows potatoes out of count owing to its heavy transpiration.

"Suitable catch crops are, in the south, white turnips of the type of 'Early White Stone,' 'Garton's Six Weeks,' &c. Farther north rape is an excellent crop for the purpose, while ryegrass would also be a good crop for the purpose; a little vetch may be added. Vetches themselves are slower growing, and do not produce such a dense cover. Mustard is also a useful crop for the purpose, and can either be eaten by sheep or ploughed in. The crop employed will, of course, depend on local conditions, and whether the crop will be ploughed in or fed, and what type of forage is desirable. The important point is that the crop should be got in immediately after the potatoes are lifted, and that it should be broadcast in sufficient quantity to produce as early a cover as possible. At best it must be remembered that the ground is left bare at a dangerous season for a short time. After potatoes have been lifted the ground is, of course, ready for the seed, as the labour required is little. After the late 2nd Early's and after Early maincrop a catch crop before winter wheat will often not be possible, especially in Scotland. These crops are more difficult to deal with in control measures. In the south there will usually be time for a catch crop, and if there is not, and if the summer be favourable for the fly, there are two possibilities: (1) grow a winter catch crop to conserve manure, and sow spring wheat in the area concerned; (2) sow winter oats instead of wheat in the Early maincrop break, provided the land is suitable and not too rich to allow of a standing crop's being obtained.

"*II. Alteration of the Rotation.*—(The spring wheat and winter oat suggestions above should really come also under this heading.) The suitability of wheat to follow potatoes is great, and considering the far-reaching effects an alteration of rotation may have, such should only be made if the pest be repeatedly destructive, and only after very careful consideration.

"(*a*) The first alteration that might be recommended is the reduction to a minimum or the elimination of Early maincrop or 2nd Early varieties, provided the pest is habitually bad and protecting the soil is not possible.

"(*b*) A six-course rotation might be modified as follows:—

"1. Wheat.
2. Potatoes—Early and 2nd Early (Early maincrop).
3. Winter rape or vetches or ryegrass, followed by oats.

4. **Roots.**
5. **Barley or oats.**
6. **Seeds.**

"The potatoes would not be over-highly manured, and the large part of the artificial manure would be applied to the hay crop (the wheat, of course, would secure its usual nitrogenous top-dressing, which, however, would not need to be so heavy as in the usual rotation). The great disadvantage of such an arrangement is that wheat is a very difficult and somewhat unsuitable crop after a sow-out. The ploughing would require to be done very early, almost as soon as the first hay was off, and would require to be deeper than usual. The soddy nature of the soil would not be any disadvantage during the winter; indeed, it would tend to prevent running together. The second disadvantage is that the oat crop would be very liable to lodging if the usual heavy manuring were given to the potato crop. The labour distribution would be rather bad owing to the time the wheat land would have to be ploughed to stand drilling of winter wheat later on. The conservation of manure requires a catch crop after the potatoes (which also would tend to cause lodging of the oats), while the gap between wheat and potatoes when the land is fairly rich would tend to cause loss.

"The disadvantages of this arrangement are great, but it would only apply to 2nd Early or Early, and only where catch-cropping was not possible.[1]

"(*c*) Or the modification might be :—

"1. Oats.
2. Roots.
3. Wheat
4. 2nd Early potatoes.
5. Barley.
6. Seeds.

"This might be tried on the break where 2nd Early's would be grown. The roots would be mangolds or turnips, and would require to be lifted rather early to get in the wheat (the turnips at any rate). The disadvantage is that the potatoes would have to be very lightly manured, so that the barley would not be too strong a crop, to allow the germination of the seeds. A poorer crop of potatoes would thus have to be accepted, an objection probably sufficient to make it in most cases come second to (*b*).

[1] Here is an additional suggestion of a modification of rotation :—

(1) Seeds.
(2) Wheat.
(3) Oats.
(4) Potatoes—followed by winter catch crop.
(5) Roots.
(6) Barley with seeds.

In this case the seeds could be ploughed early without so serious a sacrifice of autumn keep, as the catch crop could be allowed to stand late. It also obviates the difficulty from lodging of oats or barley after potatoes.

"(*d*) A third alternative would be to dispense with wheat in the 2nd Early break altogether, to put in a winter catch crop, and follow by a crop of barley or oats, taking as great precautions as possible to prevent lodging. The rest of the rotation would not be altered.

"(*e*) The Forfar 7-Course rotation could be modified in a way similar to the 6-Course—viz., (1) wheat, (2) potatoes, (3) winter catch crop followed by oats, (4) roots, (5) barley, (6) seeds, (7) potatoes. The same considerations of the great disadvantages apply here as with the 6-Course.

"(*f*) The Mid-Lothian and West Lothian 4-Course could be run as an 8-Course thus: (1) wheat, (2) potatoes (Early and 2nd Early), (3) winter catch crop + oats, (4) hay, (5) oats, (6) roots, (7) barley or oats, (8) seeds. The bulk of the manure would be applied to (8), (1), and (2). The difficulty of wheat after seeds and also the danger of lodging of the oat crop (3) would again be present.

"(*g*) In Fenlands the rotation can be altered without the same need to consider manurial conservation, and as the loss due to leaching is not of the same importance, oats could follow potatoes without a winter catch crop. The difficulty of the lodging of oats is a constant one in such districts, and the potato crop would require to be very sparingly treated."

SKIN SPOT AND BLINDNESS IN SEED POTATOES.

THE failure of seed potatoes to sprout has given rise to some concern during recent years. The trouble has appeared mostly on tubers of the variety King Edward, but is also known in the varieties Ally and Majestic. Most cases of failure are ascribed to Skin Spot (*Oospora pustulans*, Owen and Wakefield). Failure to sprout may, however, be due to other causes. Excessive chilling of seed tubers kills the eyes and renders the flesh dark and netted though the tubers remain hard and firm. Unsuitable storage conditions may result in tubers assuming a wizened or rubbery ("winded") condition in which no sprouting takes place. In some varieties blindness occasionally occurs without apparent cause. Blankiness in a potato crop may also be due to sprouts being killed after they have attained some size. This is the case when sprouts which arise from blighted tubers are attacked by the blight fungus proceeding from the rooting sett or are deprived thereby of the nourishment of the seed tuber. The fungus *Corticium solani* (B. & G.), commonly known as Rhizoctonia, may also attack young sprouts. This disease is sometimes confused with Skin Spot. Owing to this confusion many farmers still refer to Skin Spot as Rhizoctonia. The latter disease, however, is quite distinct and readily identified

in the tuber stage. The tubers affected with Rhizoctonia show, on the surface of the skin, dark-brown masses of fungus strands which are jet black when wetted. They are of irregular shape and size and can be readily scraped off with the finger nail. This fungus may cause blankiness in a crop by attacking the tips of the sprouts and killing them. Generally it is only when the spring and early summer are cold and wet that this fungus is able to do damage in this way.

The symptoms of Skin Spot can be distinguished from those of Rhizoctonia in the following ways. The spots are round in shape and coloured some shade of brown or dark purple. They cannot be scraped off the skin easily, though they can be detached from the tuber by pricking them out with the point of a penknife blade. They can be so detached because they are separated from the flesh of the tuber by a layer of cork cells which forms just under the pustule and prevents the fungus from spreading into the tuber. The spots are about the size of a pin head and have a pimple-like appearance. As the pustule becomes older a narrow dark depression gradually forms right round it so that the pimple assumes the appearance of a crater. Frequently the spots occur very close to one another, completely covering a portion of the skin and rendering the tuber unsightly. When affected portions of the skin are washed, the spots have a glazed appearance due to the skin of the tuber being tightly stretched over each spot. The skin over the pustule does not rupture, and in this respect the disease can be distinguished from Corky Scab (*Spongospora subterranea*, Lagerh.). The unbroken pustules of Corky Scab may, however, be easily confused with those of Skin Spot before it assumes the crater-like appearance. As Skin Spot does not usually penetrate at all deeply into the flesh of the tuber, there is no appreciable loss when affected tubers are peeled in preparation for cooking. When a seriously affected tuber is thinly peeled the disease shows as round dark, olive-brown spots in the underlying flesh.

The practical importance of Skin Spot lies in the damage which it may do to seed tubers. If the spots are not adjacent to the eyes, no harm is done to the sprouts. If, however, the spots are around and about the eyes, the fungus is able to penetrate into the soft (meristematic) tissue in that area and to kill the dormant buds. Tubers which fail to sprout owing to infection with this fungus show blackened areas about the eyes. The fungus shows no particular predilection for the eye areas of a tuber, but obviously the spots can hardly escape distribution over the eyes of a tuber which is badly affected. If all the eyes in a tuber are killed, that tuber cannot normally produce a plant. It is rather unusual for all the eyes of a tuber to be completely killed. One bud in one of the eyes may survive and this would be sufficient to develop into a plant. Normally the buds at the rose end of the tuber are the first to develop, an occurrence to which the term "apical dominance" has been given. If all the buds at the rose end are destroyed, the sap in the tuber is

diverted to a bud in an eye at the side of the tuber. Owing to the time taken for this diversion there is some delay in the appearance of the sprout. This may be the cause of the irregular brairding of an affected crop, but the delayed appearance of a plant may also be due to the fact that it is developed from a secondary bud in a tuber all the eyes of which are to outward appearance dead. Such buds appear by pushing their way through the dead tissue of the eye. These secondary buds are quite strong and give rise to normal plants. Some time must elapse before these buds are produced, and the resulting plants are therefore considerably later than those arising from undamaged tubers. The production of secondary buds is not a general occurrence and seems to depend upon an association of warmth with a suitable state of moisture and tilth in the soil. Conversely it would seem that a cold dry condition of the potato drills resulting from a bad tilth and lack of humus is inimical to the development of delayed sprouts.

There is undoubtedly a differing varietal susceptibility to the disease. It has not been noted on Golden Wonder. Kerr's Pink, Arran Chief and Arran Banner are frequently badly affected but without damage to the sprouting eyes. On the other hand Ally, Majestic and King Edward are not only susceptible but also, when attacked, frequently produce a blanky crop owing to the eyes being damaged.

The disease is not noticeable at lifting time. Only two definite records have been made at the Department's Registration Station of the identification of the disease in late autumn, and these refer to a single tuber in each case.

The following investigations have indicated that it is possible to recognise the presence of the disease in potato stocks in the third week in December, but the samples used in the investigation are too few to admit of general conclusions being applied to all affected potato stocks.

In 1929, through the courtesy of members of the Seed Potato Trade, samples of five varieties were collected by the Department's Registration Station in the third week of December. They were examined at the time of receipt with the following results :—

No. of tubers examined—494.
No. of tubers showing Skin Spot in December—156.
No. of tubers showing Skin Spot in March—200.

The diagnosis was confirmed microscopically.

The additional infections which showed in March were very slight. It is noteworthy that on infected tubers the diseased areas did not increase in extent from December to March. The tubers were stored under six different conditions, four at a warm temperature and two at a cool temperature. It was only under cool temperature conditions that Skin Spot appeared on the additional tubers. The varieties examined were Ally, Arran Chief, Kerr's Pink, King Edward and Majestic. The

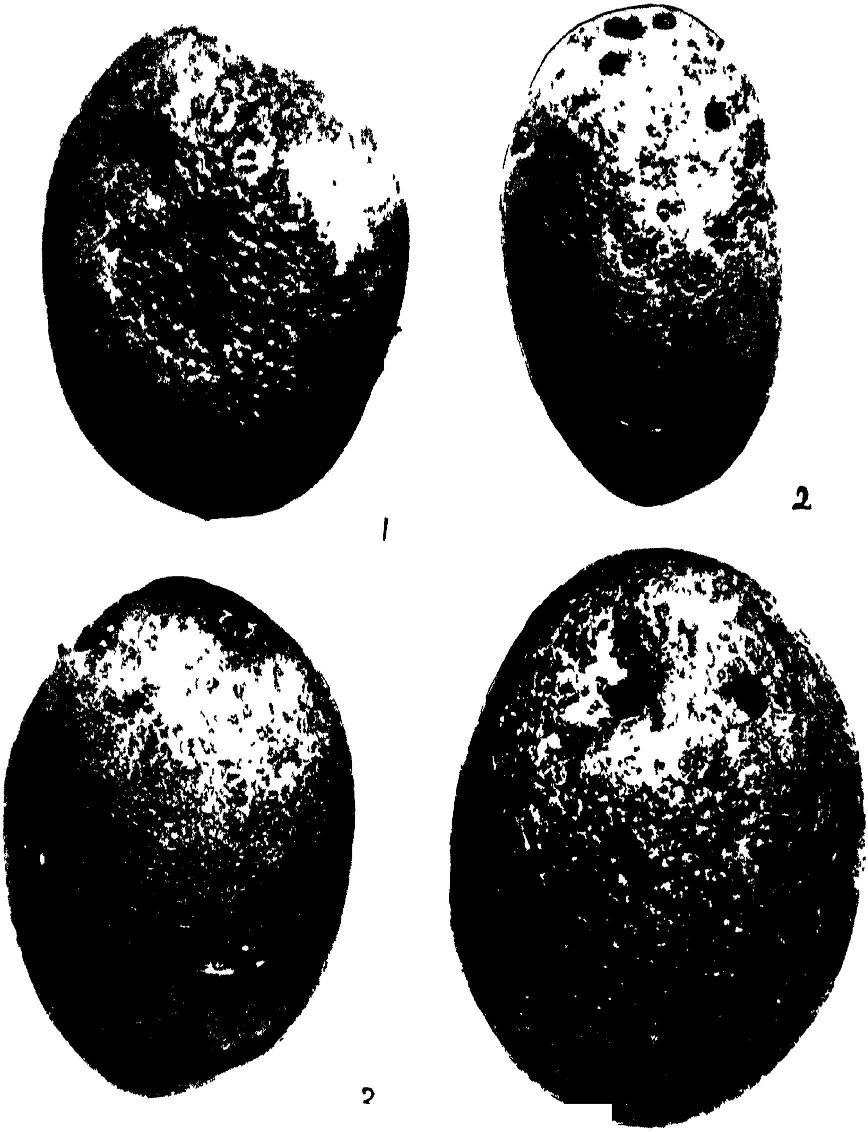
prevailing idea that the disease itself does not become evident until the spring is not borne out by these observations, which are being continued and extended in order to discover if the symptoms may be expected to be generally evident at the end of December.

All information points to the probability that the disease is essentially a soil trouble. Affected seed produces a clean crop in land unsuited for the fungus. This crop remains clean right through the winter. An affected crop may follow the planting of clean seed in land where the disease has found suitable conditions for its existence. Even though infection may be left in the soil through the planting of diseased seed, this infection is probably not of great importance. The following evidence suggests that if the soil is suitable for the fungus it is already charged with it.

In 1930, soil was procured from a private park which had not been broken within living memory. This soil was used in pot experiments with this disease. Sound tubers free from the disease planted in this soil, untreated in any way, produced plants yielding tubers which showed Skin Spot in storage.

The following experience, though not in the nature of a critical observation, supports the above experimental results. A stock of Kerr's Pink had been grown on a farm *A*. for a number of years without at any time showing symptoms of the disease. In 1929 part of the stock was planted on farm *B*. The field on farm *B*. on which the stock was planted had been in grass for at least 20 years prior to being planted with Kerr's Pink seed. No farmyard manure was applied. The resulting crop in farm *B*. was seriously affected with Skin Spot although the crop on farm *A*. was free from it in the same season. It is not known which types of land are suitable for the fungus nor what are the conditions necessary for its presumedly independent existence. The disease on potatoes is not confined to any particular location in Scotland, but has been reported from all districts where potatoes are commonly grown.

Growers are advised to take precautions against blankiness occurring in a crop as the result of planting tubers with eyes all dead. Blindness, without the apparent accompaniment of the Skin Spot fungus externally, has been noted in tubers of King Edward in December. This blindness is commonly ascribed by growers to an inherent weakness of the eyes in the sense that the buds die without sprouting owing to some physiological cause resulting in atrophy. It is more likely, however, that this inherent weakness implies only a special susceptibility to attack by a fungus which kills the eye tissues and so causes blindness. It is not reasonable to expect that such blind tubers can be discerned during the process of dressing seed potatoes on a farm. Growers who box their seed are in a position to discard tubers which fail to sprout before planting. If the seed stock cannot be sprouted in boxes, a sample should be subjected to a sprouting test in a warm dark place early in the year. Such a test would



POTATO TUBERS AFFECTED WITH SKIN SPOT

, 3, 4. Arran Chief 2 British Queen.

enable the farmer to ascertain the percentage of tubers with eyes all dead likely to be present in the stock. Quite apart from the question of Skin Spot it is admitted that different stocks of the same variety may differ somewhat in their sprouting capacity. Sometimes this difference is due to differences in dates of lifting and manner of storage, but the soil in which the crop is produced also influences the vigour of the eyes. In tubers from certain soils the eyes are slightly deeper and better defined. Tubers with eyes of this kind are to be preferred, as they are superior in sprouting capacity.

In view of the prevalent opinion that death of the eyes results when Skin Spot pustules are in or around the eyes, an obvious safeguard is to discard all tubers severely affected with Skin Spot. The earliest date at which the Skin Spot pustules can be observed readily on unwashed tubers varies according to the severity of the attack, but in general there should be no difficulty in identifying them from the beginning of February onwards. Exporters should therefore be able to ascertain when the seed is despatched in the early spring whether or not it is affected with Skin Spot. The illustrations and descriptions supplied are clear enough for any grower to understand, even if he were not already acquainted with the disease. The presence of Skin Spot would seem to be of particular importance in the varieties King Edward, Majestic and Ally, the eyes of which are easily damaged.

Summary.—Attention to the following points will enable growers to mitigate the trouble caused by blindness in potato stocks :—

1. The planting of the varieties King Edward, Majestic and Ally on land known from previous experience to produce stocks affected with blindness should be avoided.

2. If blindness is suspected in a stock, the tubers should be sprouted in boxes prior to planting so that blind tubers can be discarded.

3. Tubers severely affected with Skin Spot should be discarded during dressing operations in the spring, particularly the varieties King Edward, Majestic and Ally.

4. While bad tilth and lack of humus are always detrimental to yield, these conditions are particularly harmful when the tubers are of poor sprouting vigour, as the capacity to sprout is often thereby inhibited altogether.

Acknowledgment is made of the following articles :—

1. " The Skin Spot Disease of Potato Tubers." M. N. Owen, Royal Botanic Gardens, Kew. *Bulletin of Miscellaneous Information,* No. 8, 1919.

2. " The Causative Organism of Skin Spot of Potatoes." W. A. Millard and Sydney Burr, Royal Botanic Gardens, Kew. *Bulletin of Miscellaneous Information,* No. 8, 1923.

Note.—For the purpose of obtaining facilities for investiga-

tions during the growing season the Department invites the provision of information regarding the location of potato crops which are planted in land known from previous experience to be liable to produce stocks showing blindness.

Poultry Keeping in Scotland.

THE growth of the poultry industry in Scotland has been one of the most interesting features of post-war agricultural development. Few people attempted to earn a living from poultry farming in Scotland before the war; the costs of housing and feeding in relation to prices obtained for eggs and table poultry did not leave sufficient margin for a profitable return from commercial egg and table poultry farming alone. Pedigree breeding of utility poultry for egg production, which involves the trap nesting and egg recording of all birds was, however, being developed; as such work demands strict personal attention to individual birds, it naturally became the full time occupation of those who could concentrate on this branch of the industry. But general farmers and "back yarders" were slow to appreciate the importance of pedigree stock for improving their flocks, and still more so to take advantage of the modest efforts of specialist breeders in Scotland. Some were quite ready to give good prices for stock from well-advertised breeders in England and other countries, but unwilling to give more than a few shillings to Scottish breeders producing equally good and more suitable birds. Accordingly the returns obtained by such specialists were not commensurate with the labour involved.

Publicity is of great importance to those selling breeding stock, but Scotland has no utility poultry paper of its own; agricultural and stock journals have given what support they can, but Scottish utility poultry keepers have been much more reticent than their English and American colleagues in publishing the results of their experience.

Before the war the only prominent Scottish poultry keepers were the fanciers or exhibition poultry breeders. They, however, produce a distinctive class of bird which is rarely suitable for general commercial purposes, although utility and fancy standards are now less far apart than formerly. Poultry shows depend for their support upon the Exhibition breeder.

The advent of high prices for eggs during and after the war and more recently of low prices for imported feeding stuffs led to a great expansion in poultry production—in Scotland there was an increase of 50 per cent. between 1913 and 1931—and during the last twenty years commercial egg production from good quality stock has become a profitable industry not only on the general farm but for the specialist poultry farmer.

This increase in production has been accompanied by a very marked improvement in methods of poultry keeping, much of

the credit for which is due to the enthusiastic and valuable assistance provided by the County instructresses attached to the three Scottish Agricultural Colleges. Their lectures and advisory visits have had very considerable influence in achieving improvement of stocks, feeding, housing and marketing of produce, while their advocacy of trap-nesting records and their encouragement of pedigree breeding have helped to make possible many of the developments of recent years.

A further important factor in assisting the industry was the establishment at Seafield, Roslin, Midlothian, in 1924 of the Scottish official Egg Laying Test. The main object of the test is to demonstrate the value of selected birds as potential breeding stock for egg production, and to afford information on feeding, trap nesting, housing and general management.

Whilst the average numbers of eggs laid per bird since the Test started has been maintained, the size of egg has been improving. Weights of birds are recorded on arrival and at the end of their 48 weeks' production. By carefully studying these records and noting the breeders whose stock makes consistently good records much helpful guidance may be obtained.

The Laying Test is the pedigree breeders' shop window. A visit enables comparison to be made between the stocks of different breeders and with their records regularly published in the reports. It has done much to draw attention to Scottish breeders' records and thus to encourage economic returns for good breeding stock.

Systems of Poultry Keeping.—At the present time profitable returns are being obtained from poultry on one or other of the following systems :—

1. Commercial Egg Production. Stocking the land to its full capacity, the birds being usually housed in large numbers.
2. Pedigree breeding, i.e. the production of trap nested and pedigreed stock for sale of eggs for hatching, day-old chicks, 3-6 months-old pullets and stock cockerels.
3. Egg production as a separate branch of general farming enterprises, varying in extent from 50 to 20,000 birds. The birds are usually kept on free range, so that there is no interference with the ordinary stocking of the farm.

Two other lines of poultry keeping have not so far been developed to any extent in Scotland, viz. :—

1. Table poultry production :—The breeding or purchasing of birds of suitable breeds for fattening and cramming for table purposes.
2. Hatcheries :—The artificial incubation of chicks from stock belonging to the hatchery, or more often purchased from reliable breeders bound by contract to supply regular quantities during the hatching season. The purpose of these is the sale of day-old chicks or half-grown birds.

Though these five systems of poultry keeping have been shown separately, they are sometimes combined as a joint venture. Especially is this the case with the pedigree breeder who requires generations of birds to develop strains or families worthy of winning high honours consistently in laying tests in order that he may establish a reputation as a first-class utility pedigree breeder. It is no unusual thing when purchasing a male bird to get with it a certificate giving its pedigree for five or even seven generations, with particulars of egg production of each of its female ancestors for one or more years. The production of such birds possessing highly fecund ancestry, stamina and good characteristics of the breed represented, naturally costs much time and money and involves many initial failures, and in the meantime the wise producer will depend upon the new laid egg trade for profitable returns.

Facilities available for intending Poultry Keepers.—As the various branches of poultry keeping are attracting large numbers of recruits, it may be of interest to indicate briefly the requirements and training and other necessary facilities available. Anyone entering the industry should have a real taste for the work and be prepared to devote long hours each day of the week to the business. Good business ability for buying and selling and for organising the lay out and work of the farm is essential. Handiness with tools and knowledge of electricity are valuable assets, and if pedigree breeding is to be attempted, particular attention to detail in the keeping of records and books is required.

Stocking.—Poultry farming may be started by the purchase of :—

(*a*) Eggs or day-old chicks in spring;
(*b*) three to six months old pullets in summer; or
(*c*) breeding pens in autumn.

In each case the unwary may fail through obtaining diseased, unprofitable or unsuitable stock, and the beginner would be well advised always to rely upon expert advice. Particulars of breeders whose stocks have been selected for sale of eggs and day-old chicks and cockerels under the Department's schemes may be obtained from the College instructresses or from the Department.

Capital.—The capital necessary will vary according to circumstances. Probably the ideal way to start is to build up stocks slowly in spare time whilst continuing one's usual occupation. It is a great mistake to lay out a poultry farm on a large scale before one has obtained a considerable amount of experience. The results of research and experiments are constantly changing our outlook on poultry plans and management. There are farmers keeping poultry successfully in slatted floor or intensive or semi-intensive houses as well as in the older systems, whilst newer methods such as " folding " are being tested out.

Successful poultry farms have been started on £400 to £500

of capital or less after experience has been gained. Poultry farming should be looked upon as a means of producing a small but steady income, not as a speculative venture capable of producing wealth.

Site and Housing.—The area of land required will depend not only upon the system of farming to be adopted but also upon the method of housing. For slatted floor or colony housing 20 acres of dry well-drained rough pasturage, preferably on a sunny slope, might be suitable; for intensive or semi-intensive methods 5 to 10 acres or even less might do. Cost of housing would vary from 5*s*. per bird for slatted floors upwards to say 15*s*. per bird for intensive houses. It should be remembered that the Scottish climate demands strong substantial houses capable of withstanding our severe weather conditions. It is a false economy to purchase inferior houses. One may build one's own houses or purchase them from any of the many reliable Scottish firms which produce well-designed and finished houses at keen cut prices. It is important to consider nearness to good markets for the products of the farm and to cheap centres for feeding stuffs. In England a return of £3 per ton may be obtained from fruit farmers for the disposal of poultry manure, but so far there has been little real demand for it in Scotland.

Labour.—One man may handle 800 to 1000 birds for commercial egg production or 200 to 700 pedigree stock according to the completeness of recording, methods of housing and convenience of lay out.

Information on Prices.—Egg and poultry food price lists are compiled weekly by the Department of Agriculture for Scotland and distributed to the Press. Some of the daily papers also collect and publish returns. A few co-operative enterprises are in operation under the auspices of the Scottish Agricultural Organisation Society, 5 St. Andrew Square, Edinburgh. Advantage may be taken of the Scottish National Mark scheme under the Agricultural Produce (Grading and Marking) Act of 1928 by private producers whose production warrants it.

Returns.—People who appear to make a big return from a few hens in a backyard may be disappointed in the annual profit from poultry on a farm. From 5*s*. to 6*s*. per bird for commercial egg production may be taken as a moderate estimate of the profits which have been made.

Accounts.—In the keeping of accounts advice may be obtained from the Agricultural Colleges.

Marketing.—Advice on marketing together with publicity posters for those registered under the Scheme for National Mark Eggs is available from the Department of Agriculture for Scotland.

Training.—(1) *Institutional.*—The three Agricultural Colleges, to which further reference is made later, employ poultry instructresses, one in each county, to lecture, teach and advise the public in poultry keeping. This service is provided free of charge. Courses of poultry training are given at the Poultry

School, West of Scotland College of Agriculture, Auchincruive, by Ayr. The College Diploma [C.D.P.] course requires a complete year at the Poultry School and two winter sessions at one of the three Agricultural Colleges. A Junior three months' poultry course starts at the Poultry School in October; the Senior six months' course in January, and the Advanced six months' course in April. Shorter courses of special practical work may be arranged at any time of the year.

Craibstone School of Rural Domestic Science at Bucksburn, Aberdeen, under the North of Scotland College of Agriculture, provides a six months' training for girls in poultry keeping, dairying, cookery, laundry and housewifery, &c. The course is intended for girls returning to farms and commences in January or July.

The National Poultry Diploma [N.D.P.], instituted by the English National Poultry Council in 1921, requires a further course in addition to that outlined for the C.D.P. It is, at present, the highest qualification obtainable in this country.

(2) *General Practice.*—Poultry farmers are sometimes willing to take beginners as pupils. Premiums are charged, but for a really competent worker engaged for a reasonable period it may be possible to get instruction free in return for the student labour, only the cost of maintenance having to be paid. Care should be taken to arrange that training and insight into the whole of the farm enterprise will be given. Courses for training in hatchery practice or table poultry production and training in egg grading, testing and packing might perhaps be arranged on some large plants specialising in any of these branches, but training of this nature is less likely to be available in Scotland than in England.

Organisations and publications which might be helpful to the prospective poultry farmer are briefly as follows :—

Poultry Societies.—

The Scottish National Poultry Council (Secretary, D. Macpherson, 2 London Street, Edinburgh), is a federation of poultry keepers and societies initiated for the purposes of (*a*) uniting the poultry-keepers of Scotland for their mutual benefit; and (*b*) advancing the knowledge of the science and art of poultry keeping.

The Scientific Poultry Breeders' Association of the United Kingdom is also a helpful society and has a Scottish representative on its Council. An experimental farm and a poultry food scheme are included in its activities.

The World's Poultry Science Association (Secretary, Dr. G. F. Heuser, Ithaca, N.Y., U.S.A.) has been instrumental in promoting triennial World's Poultry Congresses since 1921. The International Review of Poultry Science is issued quarterly to members and contains a synopsis of recent poultry research reports. The Editor is Dr. B. I. C. te Hennepe, Rotterdam (Holland). Sir Edward Brown,

60 Castellain Mansions, London, W.9, would answer Scottish enquiries.

Colleges of Agriculture.—The address of each College, along with a note of the respective areas for which each is responsible, is appended. Prospective poultry keepers are advised to make application for any information or assistance required to the Secretary of the College in their area.

Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh. Counties of Angus, Perth (East), Clackmannan and Kinross, Fife, West Lothian and Peebles, Mid and East Lothian, Selkirk, Roxburgh and Berwick.

West of Scotland Agricultural College, 6 Blythswood Square, Glasgow. Counties of Argyll, Perth (West), Dunbarton, Stirling, Renfrew and Bute, Lanark, Ayr, Wigtown, Kirkcudbright, Dumfries.

North of Scotland College of Agriculture, 41½ Union Street, Aberdeen. The northern counties, including Orkney and Zetland and the Western Islands.

Calendars of courses and leaflets and bulletins on specific poultry matters are published from time to time. Short poultry lectures and classes are held at local centres throughout the winter and spring.

Publications.—The following leaflets referring to poultry keeping are issued by the Department of Agriculture for Scotland :—

1. *General.*—Leaflets; No. 61—" The Department and its Work "; No. 59—" Scientific and Technical Advice to Farmers."

2. *Land Settlement Schemes.*—Leaflet No. 63—" Small Landholders (Scotland) Acts, 1886-1931," and Leaflet, " Land Settlement in Scotland."

3. *Poultry Improvement Schemes.*—Ag. 12, Poultry Stations (List of addresses of breeders selling hatching eggs and day-old chicks and also lists of breeders of approved cockerels). Egg Laying Test (List of Competitors, Monthly and Final Reports).

4. *Marketing Schemes.*—Leaflets Ag. 149, Agricultural Produce (Grading and Marketing) Act, 1928, Designations and a National Mark for Hen Eggs produced in Scotland. Ag. 198, Marketing Eggs—Advice to Producers.

A number of poultry publications issued by the Ministry of Agriculture may be obtained from the Stationery Office, 120 George Street, Edinburgh.

Much information and guidance of an up-to-date character may also be obtained from weekly, monthly and annual specialist poultry papers and journals.

The following article is contributed by A. M. Smith, B.Sc., Ph.D., Edinburgh and East of Scotland College of Agriculture.

The Storage of New Potatoes.

In the early months of the year there is an undoubted demand on the part of a section of the public for new potatoes, and a ready sale of produce imported chiefly from the Canary Islands and Spain. There is also a general feeling, which is supported by experimental evidence, that much of this imported produce, sold as new potatoes, is merely a surplus from the previous crop, which has been stored under such conditions as to preserve the fresh appearance of the tubers over autumn and early winter. The following is a short account of some experiments carried out during the past two seasons to determine whether home-grown potatoes might be stored in such a way as to preserve the flavour and usual characteristics of new potatoes until the beginning of the year. Many growers frequently bury potatoes or leave them in the ground unharvested for the purpose of securing some fresh potatoes during winter, but such a practice is obviously limited by conditions of soil and climate and could not be carried out generally with success.

Growing the Potatoes.—It is necessary to harvest the potatoes before they have reached maturity and their skins have thickened; hence the first question that required consideration was whether the crop should be planted at the usual time and lifted early, or planted later and lifted at the usual time. Both methods have been tried, and any advantages which one possessed over the other seemed to depend mainly upon local conditions of management. In 1930, for example, experiments were carried out with the variety Duke of York planted at the usual time for the district and lifted a week or two earlier than usual. Tubers, which were excellent both in appearance and cooking quality, were removed from storage in January 1931. In the same season samples of Duke of York, Great Scot and Bishop were planted as late as the beginning of July. Growth was rapid, but the crop was badly attacked by blight; it was lifted, however, when immature at the beginning of September, and stored under various conditions until January, when tubers were obtained bearing a marked resemblance to freshly dug immature potatoes.

Storage.—The second point examined was the nature of the storage. The possible use of cold storage or "gas stores," as successfully employed for fruit, was dismissed as being impracticable, and attention was directed to methods which might conveniently be adopted on the farm. These were concerned mainly with the question of securing a fairly low and uniform temperature and yet avoiding the possibility of injury by freezing. In the laboratory this was done by keeping the potatoes in boxes in a cool, thick-walled store devoid of any direct source of heat. In the field it was found possible to make use of an old sand pit close to the farm on which the potatoes were grown. The absence of such a convenient site need not

be an insurmountable difficulty, provided adequate drainage can be secured in the open or suitable insulation is arranged indoors.

Another question relating to storage was the type of packing material. In the field three forms were tried, viz. :—(*a*) sand, (*b*) ground peat moss litter, (*c*) a mixture of equal volumes of sand and litter; all three were used under moist and dry conditions respectively. In the laboratory the same types of packing were used, and in addition an attempt was made to determine the influence of aeration. In one set of experiments the potatoes were packed in wooden boxes with close fitting lids; in another similar set the potatoes were packed in tin boxes previously perforated on all sides with a large number of holes. Generally speaking, there was no marked difference due to the type of box used, and the potatoes retained their appearance and firmness best in the mixture of moist peat and sand.

Results.—The accompanying table contains a few results obtained this winter with tubers of the variety Baron. The crop was planted at the usual time, but the potatoes were dug a few weeks before normal lifting and were packed in moist and dry mixtures of equal volumes of sand and peat moss. The columns headed " non-aerated " and " aerated " refer to the wood and tin boxes respectively.

Storage.	*Dry.*		*Moist.*	
	Non-aerated	*Aerated.*	*Non aerated.*	*Aerated*
Original percentage of moisture in packing ...	–	–	23·1	23·1
Final percentage of moisture in packing ...	3·0	3·0	9·7	19·7
Per cent. change in tuber weight	– 3·54	– 3·10	nil	+ 2·51
Per cent. weight of sprouts formed	0·80	0·75	1·32	1·72
Final per cent. moisture in tubers	77·8	77·7	80·5	78·7

The figures relating to the changes of weight and the proportions of moisture in the tubers after storage indicate that the water content of the packing material plays an important part in preserving the weight and firmness of the potatoes. The loss of water from the non-aerated moist packing could be largely accounted for by absorption by the wood. The moisture content of the tubers before storage is not known.

One difficulty which has not been entirely overcome is the retarding of sprouting, but under suitable moisture conditions the formation of small sprouts does not materially reduce the firmness of the tuber and the skin may remain quite thin. The weights of sprouts formed as a percentage of the tuber weight are given as a matter of interest. It is a question closely related to variety, and must be considered along with the necessity of dealing with varieties whose tubers possess suitable properties in regard to shape, skin, depth of eye and possibly

colour of flesh, for these qualities are probably of greater importance in this connection than cooking quality.

Although further investigation is required to establish the best conditions of storage for different varieties, the preliminary work done has shown that it is quite possible to provide, at reasonable cost, potatoes which may readily be purchased by the consumer who desires the peculiar qualities of a new potato. It is not suggested that such material should be sold as new potatoes; but there is no reason why the farmer should not set aside a small proportion of his crop for special treatment in order to meet the demand of some consumers for potatoes possessing certain qualities of flavour, appearances, &c. The extra labour and expense involved in the storing, selecting and marketing of these potatoes would be adequately repaid by the much higher prices which they would command.

The writer would like to express his indebtedness to Dr. A. Lauder, Dr. T. P. M'Intosh and Mr. A. Robertson for helpful suggestions and assistance during the investigation, and to Mr. T. Baxter, Dolphinstone, Messrs. Dobbie & Co., Ltd., Edinburgh, Mr. Andrew Hamilton, Glasgow, and Mr. R. L. Scarlett, Inveresk, for material and facilities for carrying out the work.

Salt for Stock.

THIS article is contributed by Mr. W. Thomson, The Rowett Research Institute, Bucksburn, Aberdeen.

The importance of common salt in the feeding of farm animals has been known for centuries. One could point to numerous interesting passages in early classical writings which show that farmers in bygone times fully recognised the value of salt. They believed that it had an influence in promoting fecundity and increasing milk supply. During the late 18th and early 19th century several treatises on the use of salt were written in which accounts are given of the benefits which accrue from its use for farm animals, and in which the practice of feeding it either as a lick or mixed with hay is recommended. These early writers appreciated the high nutritive value of the pastures of salt marshes, and observed that animals deprived of salt ate less, lost condition and very often became sterile.

The first systematic tests to determine the requirements for salt and the precise extent of its influence were carried out in France about 1850 and show that, in both cattle and sheep, the addition of salt was accompanied by an increased rate of growth and improvement in health. The information regarding the amounts required is somewhat scanty, but the conclusions drawn from work done up to 1905 are in general agreement, and place the daily amounts in ounces at 0·75-1·5 for the cow, 0·5-1·0 for the horse, and 0·12-0·25 for sheep and pigs.

As it seemed probable that these amounts would be greatly exceeded under present day farming conditions where the object

in the attainment of early maturity and higher yield, the opportunity was taken to record the amount of salt consumed by individuals in a group of 17 Ayrshire cows upon which, at the same time, other observations were being made. All the cows were fed the same ration and were not out at grass during the two years over which the observations were made. All calved twice during that period. Salt was added to the maintenance ration at the rate of 0·7 oz. per cow daily, and to the production ration at the rate of 0·6 oz. per gallon of milk. In addition to this, the cows had access to pure salt licks. The following table shows the amount of salt which individual cows consumed from the salt licks in the period from date of calving 1930 to the date of calving 1931.

Cow No.	Milk yield, 1930 1931	Days between calving dates (1930-1931).	Salt consumed from salt licks.	Percentage of total salt consumed in the period—8 weeks before to 10 weeks after calving.
	gallons.	days.	lb.	
3	832	390	14	71
4	735	367	14	57
5	530	361	10	40
7	762	374	6	66
8	805	351	16	62
9	1028	338	18	55
10	721	389	42	47
11	890	355	9	44
12	834	359	10	60
13	803	419	4	50
14	791	374	28	50
15	1032	350	25	48
16	575	399	16	62
17	721	379	22	45
18	1263	346	8	62
19	957	336	6	50
20	827	364	6	66

It is readily seen that there is a wide variation in the amount of salt taken by the different cows. This variation cannot be correlated with the milk yield nor with the length of the interval between calving. The enormous amount consumed by No. 10 may be connected with the fact that this cow had milk-fever in 1930 and subsequently lost condition. For some time after that this animal licked as much as 2 lb. of salt weekly. The high consumption by Nos. 14, 15 and 17 is inexplicable, but it is significant that, in both 1930 and 1931, these cows had very short dry periods and were rather thin at calving time.

The special feature of interest in these observations, however, was that the cows invariably licked most vigorously during the few weeks before and after calving. In the last column of the table the amount of salt taken during the period 8 weeks before calving to the tenth week after calving is expressed as a percentage of the total amount consumed during the whole period between calving dates. In the majority of cases, at least half the annual consumption occurred during the 18 weeks round

about the date of calving. From this it is evident that at this period the demand for salt greatly exceeds the amount added to the ration.

For those cows yielding 5 gallons of milk daily a total amount of 3·7 oz. salt was added to the maintenance and production ration. Together with the average amount licked, which was about 0·7 oz. daily, this makes a total of 4·4 oz. of added salt per head daily. In addition to this the chlorine content of the ration fed, calculated as sodium chloride, amounted to 2·68 oz. daily, a figure very much in excess of the requirement given in the earlier literature mentioned above. No information is available regarding the amount of salt necessary for cows on grass, and it is generally accepted that animals on good pasture get all the essential minerals, including chlorine. On the basis of the above experiment, however, it would require a daily consumption of 130 lb. of good pasture to supply the chlorine contained in 7 oz. of sodium chloride.

No data are available regarding the amount of salt required by sheep, pigs and poultry. Indoor-fed sheep should always have access to salt, which they will freely lick without harm to themselves. The belief that salt is " poison " to pigs is difficult to understand when it is realised that pigs fed on kitchen refuse, hotel swill, &c., would obviously be having their food seasoned with salt to the human taste. In present day practice pigs are regularly fed rations containing 1 to 2 per cent. of salt, and those fed on large amounts of potatoes or maize will readily lick salt placed in their pens. In a test to determine whether salt had toxic effects, increasing amounts up to 2·5 oz. per head daily were fed to pigs without any harmful results, the animals gaining normally in weight. Results of recent poultry experiments show that an addition of 0·5 per cent. of salt to a ration of cereals and soya-bean meal increased the growth-rate of chickens by 24 per cent. and decreased the mortality by about 17 per cent. The pullets receiving salt looked healthier and laid earlier than those not receiving the supplement.

One concludes from this study that the maintenance of perfect health among indoor-fed dairy cows is dependent on their having access to considerable amounts of salt, this being especially so round about calving time. Probably the most convenient way to administer salt is in the form of licks, and by enriching the concentrates to the extent of 2 or 3 per cent. of salt. No harm results from giving cattle, sheep and pigs free access to salt at all times. These conclusions are on the assumption that water is also available *ad libitum*.

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Craibstone.

Notes from Agricultural Colleges.

Oats, 1931 : *Ceresan Treatment.*—Several years ago Scottish farmers were indebted to America for Paris Green as a preventive for grub on lea oats. Now it would appear as if they were to be equally indebted to Germany for Ceresan as a preventive against fungoid diseases. This material was first tested in Scotland by Dr. D. G. O'Brien of the West of Scotland Agricultural College (see this *Journal*, Vol. XIII, No. 3, p. 272).

A preliminary trial was made at Craibstone in 1930 when one plot in a field was sown with treated seed, the rest of the field being untreated. At no time was any difference seen between the treated and the untreated parts, the plants in the latter being as numerous and as vigorous as in the former. The seed was dry and of good quality, while the soil was comparatively light and the subsoil open, so that evidently there were either no spores of the fungus present on the seeds or the conditions were not suitable for their development.

As the results in the south-west of Scotland appeared so conclusive it was decided to give the material a thorough trial in 1931, especially as the harvest of 1930 had been wet and therefore presumably suitable for the development and spread of the spores of the fungus had they been present. Also, the field where the trial was to be made was somewhat damp, although not wet, which condition was also supposed to be favourable to the fungus.

Six varieties were used in the trial, part of the seed of each being treated with the Ceresan and part left untreated, the rate of seeding (2½ million grains per acre) being the same in all cases. Germination tests of the seed showed that all the samples were over 95 per cent. There were six plots of each variety (three treated and three untreated), one section being grown after turnips and two sections after oats (yaval).

In all cases the untreated plots brairded much thinner and the plants were much less vigorous than on the treated plots. The number of plants in a square yard of each was counted and showed fully 600 in the treated part, whereas there were only about 250 plants in the untreated part. It seems possible that the spores were on the grain, perhaps even on the embryo, and when germination started they became active and attacked, and in a great many cases destroyed, the roots, hence the thin braird. In other cases the roots were presumably only partially destroyed, hence the less vigorous plants.

The relative thickness between the treated and untreated was observable throughout the summer, there being a distinct line between them. Most visitors at Craibstone were of opinion that the treated parts in the section after turnips were in many cases too thick, and this proved to be so, so far as the standing power was concerned. The treated Victory, Star, Progress and Eagle became somewhat laid at the end of July whereas the untreated stood well up. Later on, with more wind and rain,

they became worse laid whereas the untreated parts were only slightly laid. There was no lodging in any of the yaval plots.

The average yields of grain and straw were as follows :—

	Treated with Ceresan.		*Untreated.*	
	Grain. cwt.	*Straw.* cwt.	*Grain.* cwt.	*Straw.* cwt.
Eagle ...	28·8	40·9	22·0	33·0
Elder ...	25·3	42·3	16·2	29·0
Progress . .	22·4	38·5	17·3	31·5
Star	26·9	41·9	21·2	34·4
Victory ..	26·1	44·7	22·2	41·0
Yielder . . .	27·2	43·4	19·0	33·5
Average	26·1	41·9	19·7	33·7

There was only one of the 18 treated plots that did not show an increase of grain over the untreated, and this was in the case of Victory after turnips, where they were the same. This result was not due to any inefficiency of the Ceresan but to the early lodging of the crop, which apparently affected the plants.

This year the following trials are being carried out :—

(1) Effect of treatment with seed from crops (*a*) treated in 1931, and (*b*) untreated in 1931.

(2) Effect of various rates of seeding with treated seed in different fields where soil is different

(3) Effect of seed treated with different machines.

(4) Effect of seed treated with other materials

(5) Effect of the time of treating seed.

Standing Power.—Nine varieties were sown after lea containing wild white clover in order to test their comparative standing power. Those varieties that had not stood the test in previous trials were discarded and only those that had given promise of being likely to stand were included. Victory, being a largely grown variety, was kept as a check. Three new varieties were added, viz. Eagle, and Nos. 635 and 644 from the Scottish Society for Plant Breeding.

Although the rainfall for July was about average, there were only small amounts during the month, but a fairly heavy downpour (fully ½ inch) at the end of the month caused laid spots in R. 30 and rather larger ones in Victory. Fairly high north-west winds about the 8th August sent these further down, and also Marvellous to some extent. Heavy rain (about 2 inches) and high wind on the 18th, 19th and 20th caused these varieties to go more down, and to a less degree S.S.P.B. 635 and Eagle, and the other varieties to lean or lodge in small spots, except S.S.P.B 644, which stood up well.

The final result showed that the standing power was in the following order :—

1. S.S.P B. 644	4. McG.'s Pure Line.	7. Marvellous.
2. Elder	5 Eagle.	8. R. 30.
3. Yielder.	6 S.S.P.B. 635.	9. Victory.

The yields of grain and straw were as follows :—

Standing Power Experiment, 1931.

	Grain. cwt.	*Straw.* cwt.
Elder	23·6	50·6
Victory	24·4	50·6
Eagle	29·3	53·2
Marvellous	28·5	56·3
McG.'s Pure Line	22·8	48·2
R. 30	21·0	50·8
S.S.P.B. 635	19·2	42·7
S.S.P.B. 644	17·6	35·9
Yielder	22·7	42·2

The low yields of S.S.P.B. 635 and 644 may be due to the fact that they were not treated with Ceresan whereas the other varieties were. At any rate, they were distinctly thinner. This comparatively thin stand undoubtedly helped No. 644 and may explain to some extent why this variety stood so well, as noted above in the trial with Ceresan. S.S.P.B. 644 turned out to be an early variety, being fully earlier than either Yielder or McG.'s Pure Line, and for this reason it is worthy of a further trial. The grain is comparatively short and plump and of white colour.

Eagle is a Swedish variety and the grain is rather long and thin, and unfortunately of a yellow colour, which would likely be against its being largely grown owing to the prejudice against this colour, but as it stood reasonably well and produced a good yield of both grain and straw in both trials it is also worthy of further test

Effect of Time of Cutting.—In 1930 part of a plot of Victory was cut early and another part when fully ripe Both samples were sown at the same time alongside each other in 1931, and the 1930 early cut part was again cut early (Aug. 31) when quite green, and the late part was cut when fully ripe (Sept. 17). The following yields were obtained :—

	Per acre.	
	Early cut. cwt.	*Late cut.* cwt.
Grain	20·0	22·5
Straw	51·2	42·5
Weight per bushel	40 lb.	43 lb.
Samples of grain were sifted into large, medium and small and the proportions of each were :—		
Large	23·6	33·2
Medium	44·0	46·4
Small	32·4	20·4

	Per acre.	
	Early cut.	*Late cut.*
	cwt.	cwt.
Weight of 1,000 large grains ...	44 grams.	48 grams.
,, ,, medium grains ...	36 ,,	38 ,,
The proportion of husk and kernel was also estimated :—		
Husk	71·5	74·5
Kernel	28·5	25·5

It will be noted from these figures that the quality and size of the grain of the late cut were superior, whereas there was a larger quantity of straw from the early cut.

Time of Sowing.—Seed of Victory from a plot sown early in 1930 was again sown early (March 26) in 1931, and seed from a late sown plot in 1930 was again sown late (April 23). The yields of grain and straw were as follows :—

	Grain.	*Straw.*	*Weight per bushel.*
	cwt.	cwt.	lb.
Early sown	22·2	44·4	42½
Late sown	14·1	31·4	40½

Manurial Trials.—In a manurial trial 1 cwt. sulphate of ammonia per acre was applied to Victory oats on yaval at three different periods—(1) when crop sown, (2) when brairded, and (3) three weeks later. All the plots got 2 cwt. superphosphate and 1 cwt. potash salt when the seed was sown. The results—shown below—are in agreement with previous trials, and indicate that a late application of nitrogen is less valuable than when applied earlier. An interesting feature was that there was a fair quantity of Yarr in the no nitrogen plots but very little where nitrogen was applied.

Sulphate of ammonia applied—

	Grain.	*Straw.*
	cwt.	cwt.
1. When sown	21·2	42·2
2. When brairded	22·0	44·5
3. Three weeks later	20·8	35·1
4. No nitrogen	18·3	31·0

A new concentrated fertiliser for oats was compared with ordinary manures made up to be of the same composition. They were applied at seeding time in duplicate and gave the following result :—

	Per acre.	
	Grain.	*Straw.*
	cwt.	cwt.
1. 1½ cwt. concentrated	17·8	38·5
2. ¾ cwt. sulphate of ammonia, 1½ cwt. superphosphate, ½ cwt. potash salt	20·0	43·8

Turnips, 1931.—In this district the weather conditions, especially at the end of the season, were very favourable for the growth of the turnip crop, which was generally good all over, but the winter has been so mild that they have never ceased to grow and now many plants are forming flower heads. This has had a marked effect on the feeding quality, which has deteriorated. For example, a sample of swedes that contained 13·6 per cent. dry matter in December, now (end of February) contains only 11·3 per cent.

For several years trials have been carried out where turnips and swedes were sown at different dates. These have all along indicated that where the soil is in good order the early sowing produces the heaviest crop containing the most dry matter per acre. A disadvantage of early sowing in some seasons is that a proportion may be shot. The following table shows, in addition to the quality and yield per acre, the proportion of swedes and turnips that were shot, including those that were showing flowers (end of February).

Date when sown.	Yield per acre.		Dry matter percentage.	Percentage of plants shot.	Percentage which showed flowers.
SWEDES—NORTH TYPE.	tons	cwt.			
May 1st	23	12	14·3	6	2
,, 8th	23	2	13·6	2	0
,, 15th	21	16	13·6	1	0
,, 22nd	19	2	13·2	½	0
,, 29th	17	1	13·4	0	0
June 5th	17	17	12·9	0	0
,, 12th	15	15	12·8	0	0
YELLOW TURNIPS—THE BRUCE.					
May 8th	22	14	11·3	14	3
,, 15th	23	2	10·9	11	2
,, 22nd	24	3	11·5	6	1
,, 29th	21	10	11·4	3	0
June 5th	21	14	11·4	1	0
,, 12th	19	3	11·7	½	0
,, 19th	17	15	11·0	0	0
,, 26th	15	15	11·1	0	0

Another feature this season is the large proportion of swedes with long castocks. The following lists give varieties tried, with long, medium and short.

Long.	*Medium.*	*Short.*
Acquisition.	Angus Champion.	Aberdeenshire Prize.
Caledonian.	Best of All.	Balmoral.
Golden Melon.	Defiance.	Buchan.
Inglestone.	Dreadnought.	Inverquhomery.
Mungoswell Giant.	Eclipse.	Bangholm.
Magnificent.	Excelsior.	

Long.	*Medium.*	*Short.*
Rentpayer.	Leighton's Bronze Top.	Kinaldie.
Stirling Castle.	Majestic.	Picton.
XL All.	Mancunian.	
	Masterpiece.	
	Supreme.	
	Tipperary.	
	Wilhelmsburgher.	
	Victory.	

Every year an occasional turnip is seen with mottled leaves (somewhat like mosaic). In the 1931 crop the proportion appeared to be greater than usual and the number increased as the season advanced. The following results from a rotation experiment which has been going on since 1922 indicate that it is largely due to a deficiency of (1) phosphate (especially soluble), and (2) nitrogen. This may be due to the fact that during this long growing season the available phosphate and nitrogen have been largely exhausted.

	Percentage of plants with mottled leaves.
1. No manure	90
2. Complete manure with superphosphate as phosphatic manure	2
3. Complete manure with ground mineral phosphate as phosphatic manure ..	29
4 No phosphate	43
5. No nitrogen	29
6. No potash	6

The Bruce.—The Bruce Purple Top Yellow turnip again resisted finger-and-toe better than any other variety of either turnip or swede. The following yields were obtained on badly affected soil :—

	Per acre. tons	cwt.
Bruce	31	8
Ordinary Purple Top	5	6

Many reports of the Bruce, received not only from Scotland but also from England, speak favourably of its resisting power. Among samples tried at Craibstone there have been some, however, which were less resistant than others. Generally, those from the Skene district originally received from " Sandy Robb " have been most resistant; those from the Buchan district (Tammie Mackie) have been more varied. While some have been good, others have been somewhat mixed, there being a proportion of a large softer type which were less resistant. Buyers, and especially seed growers who intend to grow the Bruce for seed, will require to take every precaution to see that

their stocks are true and have come off land affected with finger-and-toe.

The Wallace.—A year or two ago an occasional Green Top Yellow was observed among the Bruce. Several of these were seeded in 1930 and seed was sown alongside ordinary Green Top Yellows last year. While all were more resistant than the ordinary, one selection was distinctly superior. It has been named the Wallace. Like the Bruce, it was not entirely resistant when grown on badly infected land, but infection was almost entirely confined to the roots, the bulbs generally being quite healthy. The following figures show the relative yields :—

	Per acre. tons	Per acre. cwt.
Ordinary Green Top Yellow	3	6
The Wallace	22	9

Further selections of the Wallace were seeded last year and will be sown this year.

Resistant Swedes.—Until last year no swede has been found to be at all resistant to finger-and-toe. Possibly the best was the Coxton, but even it was far from satisfactory. Mr. C. Stohl, Copenhagen, who visited Craibstone in 1930, kindly promised to send seed of two Danish varieties that had been found to be very resistant in that country. These were Wilhelmsburgher, a green globe, and the Herning selection of Bangholm, a purple globe. Both of these were distinctly superior to all other swedes, as the following results show :—

	Per acre. tons	Per acre. cwt.
1. Wilhelmsburgher Green Top ...	19	10
2. Herning Bangholm Purple Top ...	11	13
3. Coxton Purple Top	7	1
4. North Type Purple Top	4	3
5. South Soft Type 1	2	9
6. Do. do. 2	0	0

Nowadays many farmers apply the dung for the turnip crop on the surface and plough it in. While some raise the drills, sow the artificials and close the drills and sow the seed, others sow the artificials on the flat and then raise the drills and sow.

In order to test these methods, part of a field was drilled twice and part once. The soil was comparatively light and shallow. All along the once drilled part looked best, and this is borne out by the yields, which were as follows :—

	Per acre. tons	Per acre. cwt.
1. Drilled twice	17	8
2. Drilled once	20	15

A trial was made with the new concentrated fertilizer for turnips, which was compared with ordinary manure made up to

be of the same composition. Dung was used in both cases. The results were :—

	Per acre. tons	cwt.
1. 3 cwt. concentrated fertilizer	24	4
2. ¾ cwt. sulphate of ammonia, 2 cwt. superphosphate, 1½ cwt. ground mineral phosphate, ⅝ cwt. muriate of potash	23	6

Tomato-Growing Industry in Scotland.

TOMATO cultivation on a commercial scale was started in Scotland about half a century ago, but at that time tomatoes were regarded more or less as a luxury and had but a limited market. Since the beginning of the present century, however, the dietetic value of tomatoes and their palatability either in the raw or cooked state have come to be generally appreciated, and have given rise to an enormously increased demand. This has led to a rapid development of the industry within the last twenty years, and an area of over 160 acres is now devoted to the crop in Scotland.

Lanarkshire, with over 100 acres, is the most important growing district; Ayrshire has upwards of 18 acres; Renfrewshire, approximately 8 acres; the Lothians, Angus and Stirlingshire, upwards of 8 acres; and Dunbartonshire, fully 5 acres; Aberdeenshire, Fife and Kinross-shire, 2 acres each; and most of the other southern and eastern counties have small areas of about 1 acre. It is not surprising to find that the greatest part of this acreage is centred in the Clyde Valley. From its natural advantages favourable to fruit growing and its proximity to the most densely populated district in the country, this region is ideally situated both for the growing and marketing of the crop. It is interesting to note, too, that the failure of the strawberry crops in this area during recent years owing to the ravages of disease has resulted in many strawberry growers taking up tomato cultivation.

A survey of the area under glass demonstrates the remarkable diversity of sites and soils used for the cultivation of the fruit. In many cases little attention has been paid to the advantage of selecting a site in order to ensure the maximum natural heat and shelter. Houses are found in open and in shaded valleys, on hill-tops, and on hillsides with northerly and with southerly aspects; some are situated on practically level ground and others on slopes with gradients varying from slight to excessively steep. Small consideration also seems to have been given to the type of soil selected. All grades ranging from the stiffest clays to the finest of dry sandy loams are used, and it is somewhat remarkable to find that the tomato crop seems to thrive well in all classes of soils, though some impart a better flavour and give

firmer fruits than others. Nevertheless this haphazard selection of sites and soils is not to be commended; and growers are advised to give careful consideration to both these points, which have an important bearing on the maintenance of healthy, disease-free crops. All growers sooner or later recognise that a perfectly ventilated house is the best safeguard against fungoid diseases, and that the choice of sites as well as the form of construction of houses is an important factor in this respect.

Construction of Houses.—The commonest type of house in Scotland is from 100 to 200 ft. long and from 15 to 16 ft. wide. These are generally placed side by side in lots of five, ten or up to twenty.

The height of the houses to the eaves varies from 2½ ft. up to over 7 ft., but the type now favoured by growers is at least 5 ft. high at the eaves. The height of the central ridge is generally about 11 ft.

Bricks are used for the foundations, which rise fully a foot above the outside ground, and also for building the stokeholes round the boilers outside the lower end of the houses. Occasionally stokeholes are incorporated in the houses, but divided from them to prevent harmful fumes from entering.

The rest of the structure is of wood, with wooden gutters running the entire length of the houses between each section. The normal method of heating is by means of hot-water pipes fed from boilers in which anthracite coal is burned.

Cast-iron water pipes of about 4 inches diameter are used in the circulatory heating system. These are generally placed in double row horizontally one above the other round the inside of each span of glass and continued across the ends of the houses. Occasionally the upper row of piping is placed just below the eaves with the object of counteracting to some extent the harmful effects of draughts at this point. In some of the wider types of houses of from 18 to 30 ft., pipes are run round the walls and down each side of the central path to give an even distribution of heat.

Ventilation is provided by lifting lights placed alternately on each side below the central top ridge of the houses. These are controlled by a lever placed beside the door at the house ends. In general these ventilators open at the bottom, but some houses have them fitted to open at the top. From what was noted this latter style has its drawbacks, as a dead spot in air circulation is created between the eaves extending to about the centre of the roof on either side. The glass in this area was almost invariably covered with a film of moisture.

In central Scotland a type of house was viewed which differs in many respects from the common type. The sides are single brick thick to the eaves and buttressed at intervals, and rise on the outside about 4 feet above the ground level and on the inside about 6 feet. At about 15 inches below the eaves and at 9 foot intervals louvre board ventilators measuring about 2 feet 6 inches by 9 inches are introduced into the

walls, in addition to the usual roof ridge ventilators. The houses are placed parallel with about 6 feet of intervening space. Contrary to general belief the brick side walls do not in this case tend to draw up the plants to their detriment nor do they affect the proper ripening of the bottom crop. In the general type of house the roof crop is depended upon to supply a fair portion of the total yield; here the roof crop is of secondary consideration. The total yield over a period of years from this type of house is far above the general average. When viewed early in the season and at two later periods the crop showed great health and vigour, and the exceptionally long and well-balanced clusters of fruits were much superior to the crops viewed in any other type of house.

It is difficult to estimate how much of this is attributable to the type of house and how much to the ability of the growers, but the results are such that some consideration might usefully be given to this style of house.

Varieties and Yield.—The chief variety grown in Scotland is Ailsa Craig, while Best of All, Aldowrie, Bride's Recruit, Hippers, Stavor's M.P., Bountiful, are also popular. Under normal conditions, the first three varieties undoubtedly give the most symmetrical fruits and should be favoured on new soils; on older soils, varieties such as Hipper may be introduced in order to get size. Occasionally stocks of Aldowrie yield rather large fruits on new soils.

At present the favourite grades are from 7 to 9 and from 10 to 12 fruits per lb.

On new soils the average yield in the first season or two varies from 35 to 45 cwt. per 100 foot of glass; thereafter yields tend to diminish gradually until from 16 to 25 cwt. only are harvested. In order to counteract this falling off in yield many growers renew their soils every four to six years, utilising turf from hillsides not previously heavily cultivated and unlikely to be contaminated by such pests as wireworm or click beetles, or by fungoid spores.

Marketing.—Two types of containers—returnable and non-returnable—are used in marketing the fruits. The former are handled wicker baskets; the latter chiefly "chip spale" baskets, but recently various types of wooden boxes have been introduced with satisfactory results. Cardboard containers have also been tried, but so far have not proved successful. Normally a container holds 12 lb. of fruit. Grading is now generally carried out, either by hand or machine, by most producers. National Mark standards of grading and packing have recently been introduced and adopted, non-returnable containers lined with blue tissue paper and bearing across the lid a National Mark label being used to denote the following grades:—

Red label. Grade AA.—7 to 9 fruits per lb.
Blue label. Medium AA.—10 to 12 fruits per lb.
Yellow label. Small AA.—13 to 16 fruits per lb.
White label. Large AA.—4 to 6 fruits per lb.

Costs.—Both the initial capital outlay necessary for the establishment of glass houses and the annual expenditure involved in the cultivation and disposal of the tomato crop are exceedingly heavy.

At the present time a sum of approximately £3,850 is required to erect and equip an acre of glass along with the necessary outbuildings, while a further sum of about half that amount would be necessary for painting, replacement of glass, renewal of boilers, &c. during the thirty or forty years' effective lifetime of the houses. The present acreage under glass in Scotland represents a total capital investment of about £650,000.

Maintenance costs vary considerably according to the requirements of individual enterprises, but the following figures are given as fairly representative of the average expenditure on normal items :—

Fuel.—Over 50,000 tons of anthracite coal are consumed annually at a cost of over £80,000. This represents an average charge of £550 per acre.

Labour.—The hired labour of at least two men and four boys is required for the greater part of the season, and the minimum cost per acre may be put at £300.

Marketing.—Tomatoes need particularly careful handling, and marketing costs are consequently a very expensive item, amounting to nearly £400 per acre. Of this sum containers account for about £130, wholesale marketing expenses for about £220, and the balance covers carriage, labels, &c.

These are the principal maintenance charges to be met, but other items, including soil sterilisation, £22; resoiling every four years at £100 per acre, £25; dung and artificial manures, £82; water rates, £25; taxes and ground rent, £20; depreciation and upkeep, £190; and sundry minor expenses (twine, fungicides, &c.) bring the annual cost of maintenance to a total of approximately £1,600 per acre.

The average crop yield per acre decreases from about 43½ tons in the first year to about 33½ tons in the fourth year, the respective values at a wholesale price of 6*d*. per lb. being £2,426 and £1,875.

It is not suggested that these figures will be strictly applicable to individual cases, which must obviously show very considerable variations in yields and values, but they may be taken as representing a fair average over the total area under the crop.

Imports.—In the year 1930 the total imports of tomatoes into Britain amounted to 152,605 tons, representing a value of £4,547,237. The imports at Scottish ports for this period were 3,583 tons, almost entirely from the Netherlands, and this portion is the most serious competitor in Scotland with our home-grown produce.

Despite this competition and the high costs involved in tomato cultivation in this country, the area of glass has been increasing during the past few years at a rate of upwards of

50,000 ft. per annum. Skilful management and a high standard of working are evident throughout the area devoted to the crop and the future prospects of the industry appear to be bright.

Destruction of Scheduled Injurious Weeds.

UNDER the Corn Production Acts (Repeal) Act, 1921, the Department of Agriculture for Scotland are empowered to require an occupier of land to cut down or destroy certain injurious weeds growing thereon. The scheduled weeds are as follows :—Spear Thistle (*Carduus Lanceolatus L.*); Creeping or Field Thistle (*Carduus Arvensis Curt.*); Curled Dock (*Rumex Crispus L.*); Broad-leaved Dock (*Rumex Obtusifolius L.*); Ragwort (*Senecio Jacobœa L.*).

The idea underlying these provisions of the above Act is that of affording all owners and occupiers of land reasonable protection from wind blown seeds of these weeds. All these weeds produce seed in profusion, and even small portions of land, e.g. fence sides, if infested with these weeds become a menace to the whole neighbourhood. The object of this article is to point out how they may most effectively be dealt with, not only in order to prevent seeding but also in order to exterminate them.

Characteristics of Weeds.—With the exception of the Spear Thistle, which is a biennial, all the above weeds [1] are perennial plants with fleshy root systems. These root systems, in addition to performing the ordinary functions of a root, provide the plant with a storehouse. In the early part of the season the plant is enabled to grow rapidly and attain its full height largely because of the food stored up in the root. During the latter part of the season the process is reversed, the stem and leaves being engaged largely in manufacturing food and storing it up in the root system. If a plant is allowed to undergo this storing process without interruption it tends to become stronger from year to year; but if the storing process is checked by cutting down the stem of the plant before it has begun to return food to the root the plant tends to become weaker, and by continued cutting at the critical stage may ultimately become exhausted. Everyone is familiar with the fact that the cutting of daffodil leaves along with the blooms weakens the bulbs so much that they usually fail to flower the following season. What happens in the case of the daffodil happens also, in greater or lesser degree, in the case of the above weeds.

Preventive and Remedial Measures.—*Spear Thistle.*—As this thistle normally dies after the second year it can be effectively dealt with by cutting before seeding. If cutting is done early a second stem may be produced, but there is perhaps more danger in cutting too late, as the seed may ripen even after the stem is cut.

[1] For practical purposes, ragwort may be regarded either as a biennial or as a perennial.

Creeping Thistle.—This can best be dealt with in pasture fields by repeated cutting at the stage when the root stock of the plant has just exhausted itself by throwing up the new stem and leaves. Normally this stage is reached in Scotland about the last week of June. It will thus be seen that to delay cutting till late July or August allows the root system to recover to a considerable extent. It is true that if thistles are cut in June a second growth will usually come away. This could be cut as soon as it has reached a reasonable height, say in late July or August. If this is done the thistles are so weakened that next year they will be very much reduced both in numbers and in vigour.

The following table shows some of the results obtained in an experiment carried out in County Down by the Ministry of Agriculture for Northern Ireland. The thistles were cut by scythe and as near the ground as possible. The size of each plot was $\frac{1}{200}$ acre.

Plot.	Date of cutting in 1929.	Average height of thistles in June 1930.	Number of thistles per plot in 1930.
(1)	June and July	2 to 3 inches.	118
(2)	June only	8 inches.	194
(3)	August only	12 inches.	337

Other similar experiments at Cockle Park and at the Harper-Adams Agricultural College gave similar results. At the last named centre it was also proved that in permanent pasture thistles can be completely destroyed in three years' time by persistent cutting.

The efficacy of early cutting can also be illustrated by the fact that thistles are rarely troublesome in hay meadows in districts where the meadow hay is cut early.

In certain districts there is a fairly widespread idea among farmers that if thistles are cut late when the stems are mature and hollow in the centre, the winter rains get down the hollow stems and rot the plants. While there may be some truth in this idea, it is a matter of observation that in these districts farmers who cut thistles early are far more successful in controlling them than are those who cut late.

On vacant arable or on waste ground thistles may be destroyed by the application of chlorate of soda, a chemical used by the French and Swiss railways for the destruction of weeds on the permanent way. This chemical may be applied either dry or as a solution at the rate of about 3 cwt. per acre. It is most effectively applied at the beginning of winter. Besides completely destroying field thistles, sodium chlorate destroys the root system of most deep rooting weeds but does not destroy weed seeds. If applied at the beginning of winter sodium chlorate produces no ill effect on the succeeding spring sown or spring planted crop. The cost of the material, which runs about 30s.

per cwt., makes this method of eradication impracticable except in special cases.

Docks.—In pastures docks may be treated in the same way as thistles. If spudding is practised, care should be taken that the root stock is cut very low down, as the effect of shallow spudding is to produce anything up to a dozen new crowns springing from the old root. Pulling is facilitated after a spell of wet weather and is usually more effective than spudding. On arable land docks should be pulled and hand gathered off the fields.

The importance of the prevention of seeding in the case of docks cannot be over emphasised, as it has been proved that dock seeds may retain their vitality for ten years.

Ragwort.—This weed is known locally under various names such as Ragweed, Tansy, Stinking Willie, Yellow Gowan (Orkney), Yellow Weed, Staggerwort, Weeby, Benweed.

In view of the fact that ragwort generally disappears when land is ploughed up it is often regarded with indifference by otherwise good farmers. Actually it is one of the most injurious of the common weeds of grass land. When conditions are favourable ragwort spreads rapidly and covers considerable areas of grazing land. The greatest amount of damage is done in the early summer by its spreading leaves, which crowd out and smother good herbage plants. It is not uncommon to find that the amount of herbage is thus reduced by anything from one eighth to one quarter. In addition cut ragwort in hay is poisonous to cattle and is the cause of what is known as ragwort poisoning.

Although ragwort is a perennial it behaves very much like a biennial. In the first year it produces a rosette of green leaves without a flowering stem. Flowering takes place in the second year, after which the plant usually dies, but under certain conditions it may live on for several years.

Eradication may be effected by the following methods :—

(*a*) Grazing by sheep. Sheep readily eat ragwort in the early spring and summer, and if grazing land is regularly stocked with sheep ragwort will disappear.

(*b*) Persistent cutting as in the case of field thistles.

(*c*) Pulling by hand. Ragwort, like docks, may be pulled by hand fairly easily when the ground is well soaked.

THE following note is contributed by Dr. T. W. M. Cameron, Lecturer in Helminthology at the University of Edinburgh.

Liver Fluke and Stomach Worms in Sheep.

A wet summer precedes a bad liver-fluke season. The wetter the summer, the greater the number of fluke-carrying snails which survive and the greater the number of fluke eggs in the droppings of sheep which hatch and enter these snails. Accordingly more infective stages encyst on the grass and are eaten by sheep. The situation in England already promises

to be more serious than it has been for many years, particularly where drainage is defective and where regular dosing of sheep for fluke has not been carried out. The importance of dosing sheep lies in its preventive action, as the reduction of the number of parasites in the liver lessens the number of eggs laid and the subsequent chances of infection. Dosing obviously infected animals is dangerous and should be attempted only under supervision; dosing with small doses of carbon tetrachloride in the early stages of the disease is relatively safe. In selecting "safe" ground for sheep, it is important to remember that cattle—particularly Irish Stores—are often infected and may have rendered such ground "unsafe."

A wet summer, especially when followed by an open winter such as this, increases the dangers from stomach worms, and every effort should be made to keep lambs free from these pests this spring. There are many species of worms in the stomach and small intestine of Scottish sheep, many of them microscopic and seldom seen by the farmer. They are none the less pathogenic, and probably form the major source of loss to the sheep farmer, partly by killing young animals, but more by causing a loss in condition and debility. Many a sheep is a "bad-doer" only because it is heavily infested by worms. Moreover, there is evidence that many bacterial diseases obtain a hold owing to the presence of these parasites. The following suggestions for their control are put forward.

1. *Feeding.*—Strong sheep resist infection better than weak sheep, and the number of worms which will kill a weak sheep may be unnoticed in a strong one. Moreover, an animal which is receiving an adequate well-balanced ration will not become infected so easily as one without sufficient minerals and vitamins. Mineral licks, containing salt, bone-meal and other minerals are useful additions to the diet.

2. *Stocking.*—One worm passes thousands of eggs which hatch; each of the young forms, when swallowed, becomes an adult, laying as many eggs. Accordingly, when a pasture is overstocked, the infection rate increases by leaps and bounds. For the same reason, permanent pastures are much more dangerous than temporary ones.

3. *Separation of Lambs from older Sheep.*—Young sheep are much more susceptible to worm infections than are the older ones and show signs of disease much more quickly. Old sheep may carry worms which produce no symptoms in them, but the eggs which these worms produce will cause disease in the lambs. Lambs should therefore be kept on the safest pasture, i.e. pasture which has not carried older animals within the past few months. Hill pastures which are well drained are much safer than low-lying valleys. In special cases it may be necessary to rear lambs on bare soil, feeding them from raised troughs, while the ewes are out grazing.

4. *Use of Remedies.*—Only a few species of worms—and these among the least important in Scotland—can be successfully

treated by drugs; but where possible these should be used as some worms will be removed by them. Drugs should be given when sheep are not chewing the cud, as the drug is then more likely to reach the true stomach directly and undiluted.

THE following article is contributed by Professor Raymond T. Parkhurst, B.Sc. (Agr.), M.Sc., Director of the National Institute of Poultry Husbandry, Newport, Shropshire.

Poultry Extension Methods in the United States.

An indication of the extent to which poultry extension work is carried on in the United States is given by the official reports from the United States Department of Agriculture. In recent years, county extension agents numbering over 4,000 in the United States report yearly over 55,000 adult poultry demonstrations, nearly 57,000 boys and girls competing in poultry club projects, and as a result of this work 260,000 better poultry practices adopted. Eight per cent. of the time of the agricultural agents, junior club agents and home demonstration agents in the counties was devoted to poultry husbandry, and only two other projects, farm crops with 11·5 and dairy husbandry with 8·7 per cent., were given more time than poultry. Over 74 per cent. of the county workers reported poultry activities, a larger percentage than was reported for any other subject.

The organisation of poultry extension work in the United States differs from that in the United Kingdom. The educational field is covered in all 48 States by the United States Department of Agriculture in co-operation with the State agricultural colleges and county extension workers. There are about 75 poultry specialists giving their entire time to the direction of county poultry work, and 18 others who devote part time to poultry extension teaching. The county extension workers live in the area in which they are employed, while the State poultry specialists usually make their headquarters at the State college and travel throughout the entire State. They are sometimes directly responsible to the head of the State Poultry Department, or may be independent and co-operate more or less with him.

The National Poultry Extension Service located in Washington tends to co-ordinate the activities of the State Poultry workers through the Federal Extension Poultry Husbandman (Mr. H. L. Schader) and to centralize motion pictures and exhibit work. At present there are available for use at least 13 different reels of motion pictures illustrating modern practices of poultry raising. Charts and lantern slides can also be obtained through the Office of Motion Pictures. The Office of Exhibits prepares and arranges to display exhibits at State, interstate and international fairs and expositions. The United States' exhibit at the World's Poultry Congress was

handled through this office. Radio broadcasting of poultry subjects has also been developed through the central office.

The State poultry specialist organises his services so that these may be available either direct to the farmer or, alternatively, through the county extension organisation, which may include the county agricultural agent, the home demonstration agent and the boys' and girls' club agents. In some counties—in California for example—there are poultry or poultry and dairy specialists.

Once a year, the State poultry specialist sends out his poultry programme to each county and asks for information on the schemes in operation during the past year, those to be discontinued, the new projects which it is desired to be developed, and the approximate number of days of assistance needed from the extension poultryman. Outlines are given of new or outstanding projects. When the requests are all received, the specialist apportions his time to the counties according to his judgment of their needs.

Although each specialist is free to select and outline the schemes within his State there is a considerable amount of uniformity in the programmes of the various States. In 29 States, for example, demonstration farm flocks have been established. This project is also known as the Home Egg-Laying Contest. In each county from five to ten farms are selected on which there is modern equipment or a farmer who is willing to modernise his equipment. An agreement is made by which the farmer agrees to follow the instructions for management and record-keeping as outlined by the specialists and county agent, and in return his flock is culled, the breeders selected, and other assistance is given. These flocks serve as demonstrations of improved poultry practices in their respective communities. Field meetings and tours are held on these farms. Extension workers in poultry husbandry seem pretty generally agreed that their best work is done through these demonstrations. Lecturing and talking about new practices are helpful. but these are really effective when it is shown that their practical application definitely shows increased profits.

The Record Farms started last year in this country through the co-operation of the Harper Adams College Economic Department and the National Institute of Poultry Husbandry might possibly serve the purpose of demonstration farms when this project is more fully developed.

Culling and selection demonstrations have formed an important part of poultry improvement work in nearly every State during the last 10 or 15 years and have proved most helpful. Newer work along this line includes demonstrations in the selecting of pullets for egg production by head points and the mating of breeding pens selected from late moulting hens, when no trapnests are used.

Nearly every State has a Flock Mating or Accreditation Scheme, and there has been considerable difficulty in getting

uniformity for all States. In most cases these schemes have been turned over to associations of accredited flock owners.

The "Healthy Chick" projects go under various names, but they all have as their object the reduction of mortality, especially during the early stages. There is probably no programme attempted by poultry extension workers that has been more satisfactory.

It has been observed in certain States that flocks carried fully two hens to each developed pullet and were not producing sufficient November and December eggs. Estimates also pointed to a loss of fully 50 per cent. of all chicks hatched. Schemes were initiated with the following objects in view:—

(1) To raise fully 90 per cent. of all chicks hatched to maturity.
(2) To establish 10 well-organised brooding and rearing demonstrations in each county of the State.
(3) To raise chickens free of disease.
(4) To raise pullets to be fully matured and in production by November 1st.
(5) To grow cockerels to market weight rapidly.
(6) To aid in the selection and proper use of good brooder equipment.
(7) To produce eggs that will hatch into strong chicks.
(8) To have two fully developed pullets in October for each hen carried over.

The scheme of organisation is designed to cover a five year period. In the first year not less than five brooding demonstrations under their existing conditions are started in various parts of the county. General meetings are held to explain the methods advocated not only to the co-operators but also to poultry-keepers in the immediate vicinity. Clean ground or, when not available, wire floor runs are advocated. In the second year the original demonstrations are continued and additional co-operators are enlisted. Methods are popularised by tours and meetings. In the third and fourth years the original demonstrations are continued and a large number of co-operators enrolled. Demonstration meetings are held and the work further popularised by tours. In the concluding year there is an intensive campaign for general adoption of the recommended practices which have been demonstrated in the previous four years. The specialist has full responsibility for outlining the scheme, coaching the co-operators, and in holding the special meetings. The county agent selects the co-operators and demonstrators and the places of the meetings and does the follow-up work. The specialist prepares and keeps up-to-date a guide for co-operators to follow as to rations, management, &c. By linking the scheme with flock record work, it has been possible to get a definite check on results as to chicks started, weight and development, cost of rearing, percentage of chicks raised and the results achieved by the proper rearing of the pullets.

The results from one State show that it is not uncommon for 95 per cent. of the chicks to be raised, whereas by the old methods less than 70 per cent. was common. In the small State of New Jersey there were 1,325 co-operators in the third year (1930), representing 1,937,604 chicks, and 849 complete reports were received. Those co-operators who followed the programme (seven points) had a mortality of only 9·7 per cent. and raised 41·7 per cent. of good pullets. Connecticut reports a disease mortality of only 6·3 per cent. for 304,401 chicks raised to maturity when the programme (eight points) was followed, as compared with 14·6 when chicks and land were not clean, but the other six points were followed. In three years the average egg production has increased from 148 to 161 eggs.

Some of the other projects at present carried on in various States are :—

1. Boys' and girls' club work.
2. Breeding improvement.
3. Record of performance or supervised trapnesting at home.
4. Conditioning breeding stock.
5. Turkey production and accreditation.
6. Pullet management.
7. Egg quality improvement.
8. Co-operative marketing.
9. Caponising.
10. Killing and picking.
11. Co-operation with local and State poultry associations.
12. Correspondence courses.
13. Hatchery schools.
14. Poultry housing and housing conditions.
15. Feeding.
16. Poultry sanitation and disease control.

In addition to work on fixed schemes, the specialists deal with a considerable amount of correspondence, attend committee meetings, poultry shows and exhibits, write press articles, leaflets and bulletins, and give radio talks.

In conclusion special mention should be made of the boys' and girls' poultry club work. In recent years nearly 100,000 boys and girls have been enrolled in poultry clubs. These club members raise annually and take complete care of over a million birds. Club meetings, public exhibitions, demonstrations and county, state and national judging contests are additional to their work. It is obvious that the rising generation of farmers and poultry raisers is receiving helpful guidance and assistance from instruction by the extension service.

Horticultural Products (Emergency Customs Duties) Act, 1931.

In exercise of his powers under this Act the Minister of Agriculture and Fisheries has imposed Customs Duties on the under-mentioned articles on importation into the United Kingdom during the periods stated, viz. :—

	Duration.	Amount of Duty.
Fresh Fruit—		
Cherries	1st May–30th June (inclusive) ...	3*d.* per lb.
Currants	1st May–31st July (inclusive) ...	2*d.* per lb.
Gooseberries	1st May–30th June (inclusive) ...	½*d.* per lb.
Grapes (Hothouse) ...	5th January–30th June (inclusive) ...	4*d.* per lb.
	1st July–11th December (inclusive)	2*d.* per lb.
Plums	1st June–15th August (inclusive) ...	14*s.* per cwt.
Strawberries	1st April–31st May (inclusive) ...	2*s.* 6*d.* per lb.
	1st–15th June (inclusive)	6*d.* per lb.
Fresh Vegetables—		
Asparagus	5th January–29th February (inclusive)	1*s.* per lb.
	1st March–31st May (inclusive) ...	4*d.* per lb.
Green Beans	5th January–30th June (inclusive) ...	1½*d.* per lb.
Broccoli and Cauliflowers	5th January–31st March (inclusive)	4*s.* per cwt.
	1st April–30th June (inclusive) ...	3*s.* per cwt.
Carrots	1st April–30th June (inclusive) ...	1*d.* per lb.
Lettuce ... Endive ... Chicory (Salad)	5th January–30th April (inclusive) 1st May–30th June (inclusive) ...	8*s.* per cwt. 6*s.* per cwt.
Cucumbers	1st March–30th June (inclusive) ...	12*s.* per cwt.
	1st July–30th November (inclusive)	8*s.* per cwt.
Mushrooms	5th January–11th December (inclusive)	8*d.* per lb.
Green Peas	5th January–31st March (inclusive)	14*s.* per cwt.
	1st April–30th June (inclusive) ..	9*s.* 4*d* per cwt.
New Potatoes	5th January–29th February (inclusive)	18*s.* 8*d.* per cwt.
	1st–31st March (inclusive)	9*s.* 4*d.* per cwt.
	1st–30th April (inclusive)	4*s.* 8*d.* per cwt.
Tomatoes ..	1st June–31st July (inclusive) ..	2*d.* per lb.
	1st August–31st October (inclusive)	1*d.* per lb.
Turnips	1st April–30th June (inclusive) ...	1*d.* per lb.
Flowers, &c.—		
Cut Flowers in the following varieties :— Anemones ... Carnations and Pinks Heather ... Marguerites ... Marigolds ... Mimosa ... Narcissi (Polyanthus types). Star of Bethlehem Stocks ... Violets ... Plants in flower Foliage (excluding Asparagus foliage).	5th January–11th December (inclusive)	2*d.* per lb.
Other Cut Flowers Flowers attached to Bulbs .. Asparagus foliage	5th January–11th December (inclusive)	9*d.* per lb.
Rose Trees	5th January–30th April (inclusive)...	30*s.* per 100.

Agricultural History.

THE Agricultural History Society of America wishes to secure for inclusion in its quarterly Journal as full bibliographical information as possible relating to books or essays on agricultural history published in the British Isles. Writers of essays on farming history and the history of rural life in all its phases are therefore requested to forward details of their publications from time to time to the Associate Editor, Mr. G. E. Fussell, at 47 Maple Street, London, W.1. Information regarding sections of scientific works which contain historical data, works of general history or the history of specific trades or districts which contain sections dealing with agricultural history might also be included.

In case it may be of interest, the Quarterly Journal: Agricultural History, is obtainable on payment of an annual subscription of $3, which should be forwarded to the Treasurer, Agricultural History Society, Room 304, 1358 B Street S.W., Washington, D.C., U.S.A.

Healthy Stocks of Potatoes.

DURING the last four years the Department have offered assistance to farmers to build up stocks of potatoes of "Stock Seed" standard. This standard implies a purity of approximately 100 per cent. and apparent freedom from diseases, especially the degenerative or virus diseases such as mosaic and leaf roll, which are responsible for vast losses of produce in many districts every year.

The aim of the Department is to make available in the seed-producing areas of Scotland a large supply of all commercial varieties of the potato which shall be of the highest possible quality in regard to health and purity.

In 1926 a preliminary experiment was started at a farm in Aberdeenshire with 20 selected plants of the variety "Majestic." Now over 70 farmers in Scotland are engaged in building up healthy stocks of different varieties, with the assistance of the Department.

The procedure followed is to select plants of a particular variety which appear to be free from the symptoms of virus disease. The produce of each plant in the original year of selection is lifted separately and stored as a unit in a separate container bearing an individual number. Each unit is thereafter identified by that number. In the following year the units are planted in a turnip crop in such a way that each unit is 20 yards distant from any other unit. This amount of isolation is necessary because the tubers comprising units may have contracted infection in the year of their selection from diseased plants in their vicinity. The growing plants are examined periodically and the farmers concerned are advised which units to discard. At the end of the first year's growth in the turnip field, each unit which has attained to the necessary standard of

health is lifted separately and put into a box or sack of its own bearing the original number given to the unit. In the following year the units which have been kept are isolated as before in a turnip crop, and again unsatisfactory units are discarded. At the end of the second year's isolation in a turnip crop the satisfactory units are bulked and the produce is planted out in subsequent years at a distance of at least 20 yards from any other potatoes to prevent reinfection. In the first year of isolation a unit is discarded in its entirety if a single plant is affected with mosaic, or even if a plant is suspected of having mosaic. In the second year of isolation doubtful plants with their neighbours are removed without the whole unit being discarded if it is otherwise healthy.

For various reasons the scheme is applicable only to farms where a long rotation is practised, a condition that is most likely to be obtained in upland wet or exposed districts unsuitable for intensive crop production, but well suited to the propagation of seed potatoes since the insects that transmit virus diseases are relatively scarce.

The Department invite enquiries from potato growers who are desirous of participating in this scheme and who are in a position to comply with the requirements indicated above.

Profitableness of Farming in Scotland.

THE Department have now issued their second report on the economic position of agriculture in Scotland, based on a study of the accounts of 143 farms in 1929-30. The accounts are collected through the Agricultural Colleges, and serve as a basis for advisory work as well as for the assessment of the national situation of the industry. The report reveals the more important changes in farming practice that are taking place, and analyses the outlays and returns on the farms grouped according to district and the character of their production. The financial results were, in brief, that on only 21 out of 50 farms in the North-East area devoted primarily to cattle feeding were the farm incomes of sufficient amount to support the farm household. Among the arable farms of the Eastern area, only 7 out of 27 farms produced a livelihood, whilst on all such farms taken together losses exceeded gains by a considerable sum. In the Borders 11 out of 23 semi-arable sheep farms produced profits sufficient to meet normal living expenses, the results being better on the higher than on the lower lying farms. In the South-West about two-thirds of the farms yielded living profits, but the cheese-makers were less successful than the milk sellers.

As compared with the previous year, 33 farms fared better, but 54 fared worse, and average profits declined in most groups. The maladjustment between costs and returns indicated in the previous report, and affecting very unequally the profits in

the different sections of the industry, became worse rather than better. The course of prices suggests still less satisfactory results in many districts in 1930-31, for which period a further report is in preparation.

Copies of the report, which should be of value to farmers, county organisers and teachers in agricultural colleges, as well as to landowners, factors and others concerned with the state of the agricultural industry, are obtainable from H.M. Stationery Office, 120 George Street, Edinburgh, price 1*s*. 4½*d*. post free.

The International Yearbook of Agricultural Statistics.

THE International Institute of Agriculture at Rome has recently published the 1930-31 edition of the "International Yearbook of Agricultural Statistics," a volume of 830 pages.

In the first part of the Yearbook are classified the figures for area and population for 220 countries. The second part is composed of a series of tables comprising for nearly 50 countries the available data concerning the uses for which the total area is employed, the apportionment of cultivated areas between the different crops, agricultural production, numbers of the different kinds of live stock and the products derived from them. In the tables constituting the third part of the volume have been indicated for nearly 40 agricultural products the area, production and yield per acre in each country.

For each kind of live stock all available figures in the different countries have been grouped. A large part of the volume is devoted to statistics of the commercial movement of 42 vegetable products and 12 products of animal origin. The figures published relate to the imports and exports during the calendar years and for the cereals also during the commercial seasons. The tables of production and commerce not only specify details for each country, but also the totals for the different continents and hemispheres and for the whole world.

The part devoted to prices contains the weekly quotations of 25 agricultural products on the principal world markets; in the freights section will be found the quotations for the transport of wheat, maize and rice on the most important shipping routes; in the section reserved for fertilisers and chemical products useful in agriculture are published statistics of production, trade and prices for 15 products; in the rates of exchange section are set out the rates on the New York Exchange for the most important currencies; and in the Appendix have been brought together special chapters on the importance and distribution of the agricultural population, the distribution of agricultural holdings according to their size and mode of tenure, and forestry.

Agricultural Conditions.

During December the weather was abnormally mild and open in all parts of the country. In most western districts the rainfall during the month was considerable, but elsewhere the conditions were generally dry and genial, and farm work progressed with remarkably little interruption. Wintry conditions prevailed during the last few days of 1931. Throughout January high temperatures recurred in all districts. In the eastern counties fine, dry weather and enjoyed during the month, and in this area the cultivation of arable land made exceptionally good progress. In the west the weather during the first half of the month was wet and stormy, but the last two weeks were mainly fine and dry; in the Outer Islands, however, gales and rain were general throughout the whole of the month. Pastures remained remarkably fresh and green, while turnips that had not been lifted continued to grow in the fields and showed a tendency to run to seed. The month of February was extremely fine and mild. The rainfall was everywhere exceptionally light, while the temperature, particularly during the first half of the month, was abnormally high for the season. During the last ten days rather cold east winds prevailed and frosts occurred at night, but intervals of bright sunshine were fairly frequent, and at no time were the conditions sufficiently severe to put a stop to ploughing or other outdoor work.

The winter sowing of wheat was completed by the end of 1930, and in most early-sown fields the braird then had a strong and healthy appearance. The open weather during the winter was very favourable for the growth of the plants, and although some of the later-sown wheat lost colour slightly during the last few days of February, speaking generally the crop suffered very little damage from frosts. From the estimates furnished by the Department's Crop Reporters it would appear that in the Lothians, North-East Angus and South-West Fife the area under wheat this year will show no appreciable change. Elsewhere it seems probable that there will be an increase of about 2,000 acres in the total area under the crop as compared with last year.

The reports on potato stocks furnished at the end of January were, on the whole, most satisfactory. Some reports mentioned disease and rot, particularly among early varieties, and more especially where the crop was grown on stiff and heavy land. Such wastage as occurred among maincrop potatoes was chiefly confined to certain varieties. In several districts sprouting was more prevalent than is usual at this date. Generally, however, the tubers were keeping well, and were coming out of the pits in a sound and healthy condition. Some reports, in fact, stated that the condition of the tubers was quite as good as when they were pitted.

The continued mildness of the weather, which kept pastures fresh and green, was most favourable for sheep stocks. The dry and open conditions enabled flocks, in the highlands as well as

the lowlands, to recover from the effects of the wet conditions last summer, and reports of disease were much less common this winter than usual. Among small flocks on low ground, where early lambs are produced for the butchers, lambing has been in progress since late January. In these districts the fall of lambs was rather above the average. At the end of February breeding stocks were said to be in very good condition.

At the beginning of December root crops were reported to be rather unsatisfactory; the condition of the roots was not very good and they were unusually small in bulk. There was a probability, therefore, that before the end of the winter there would be a shortage of turnips. Many farmers in consequence took advantage of the mild weather and delayed the lifting of the roots as long as possible. Moreover, the continued growth of grass enabled them to economise in the consumption of winter keep. The supplies of turnips therefore lasted much better than was expected. At the end of February the supplies of hay were reported to be ample for requirements, but in one or two districts straw appeared to be running short. Sugar beet pulp is becoming more generally used for dairy herds, but not in large quantities.

The supply of farm workers has been plentiful generally, but during December experienced dairy hands were rather scarce in Dunbarton and Dumfries. In many districts during the winter the supply of unskilled labour was in excess of the demand.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Blindness or Blast of Oats. *C Leonard Huskins, Department of Botany, M'Gill University, Montreal. Scientific Agriculture, Vol.* 12, *No.* 4—Blindness or "blast" of oats varies in amount in different seasons, and often appears to affect the yield of grain seriously.

The author observed, at Alberta, Canada, that there was much blindness in the False Wild oats and very little in the Wild oats, and that the Banner oats seemed to have somewhat less than the False Wild. Three lines of oats selected and grown for a number of years in the Department of Field Crops of the University of Alberta, and known to breed true, furnished the material for this study. These three sorts were sown in adjacent plots at various intervals from 2nd May to 15th July 1924. The data obtained were subjected to statistical analysis The Wild oats were clearly less liable to blindness than either False Wild oats or Banner, and the False Wild oats are probably more susceptible than Banner under some conditions of growth. Figures are given to show that "blast" occurs in many very different species of oats representing all three of the principal sub-divisions of the cereal section of the genus.

The correlation between frit-fly attack and blindness, reported by Roebuck, has been confirmed by the writer to a certain limited extent. Panicles which had been attacked in the sheath by frit fly frequently emerged with the whole or part of their spikelets blind. The condition in which spikelets scattered over the head are blind did not, however, seem to be attributable to the frit fly.

The bearing, if any, of these observations made in England upon the data collected in Alberta was difficult to determine. The frit fly had not so far been a pest in Canada as in Europe.

Potato Variety Trials conducted by the Field's Division, Season 1930–31. *New Zealand Journal of Agriculture, Volume 43, No. 3, 21st September* 1931.—As a result of work undertaken by the Department of Agriculture at Ashburton Experimental Farm, relatively virus-free lines have been raised of most of the commercial varieties. This seed was used in the above trials and it offered a measure of accuracy not possible in the past. Thirty varieties were selected and trials laid down in twenty localities representative of the potato-growing districts of New Zealand.

A few of the comments on the varieties are appended.

Main Crop Varieties :—

Kerr's Pink.—An excellent variety with a wide range of adaptability. It was placed first in the maincrop trials, and was not below eighth place in any trial of the series. It has lost marks for commercial possibilities because of the pink colour of the skin.

Up-to-Date and Field Marshal.—Both yielded exceptionally well, demonstrating that good crops of these varieties can still be grown provided virus-free stocks are used.

Dakota.—A high-class variety which has unfortunately lost popularity during the last year or two. Occasional pink discoloration in the flesh of immature tubers is characteristic of the variety.

Endurance.—Gained two firsts and three seconds, and yielded satisfactorily in practically every trial. It seems most suited for light soils. It is doubtful, however, if the variety will be found suitable for shipping on account of its brittle nature.

Arran Consul.—A new importation which did moderately well, second in one trial but ninth in four.

Arran Chief.—This variety has not justified its reputation. It is probable that virus disease has been in some measure the cause of this, since the line of seed used, although the best available, was more heavily infected than other varieties in the trials.

Golden Wonder was placed last in no fewer than eight trials and only twice did it rise above tenth place. This confirms the reports from Britain, where it is considered the poorest yielding maincrop variety. Its appearance is not attractive. It is, however, an exceptionally high-quality potato, and its usefulness is probably limited to private gardens.

Early Maincrop Varieties :—

Arran Banner.—This new importation was the outstanding variety in the trials, and fully confirms reports on trials carried out in Britain. It gained first place in five trials and second in six, and only once did it drop as low as fifth in the early maincrop group.

Abundance gained two firsts and three seconds, and was never placed below fifth. This year's trials indicate that the variety has a wide range of adaptability and that its reintroduction into New Zealand has been justified.

Aucklander Short-top.—This variety, which is probably the most popular in New Zealand at the present time, produces a high percentage of good marketable tubers, and may be grown either as a second-early or maincrop. Its resistance to blight makes it a particularly valuable variety, and one which can be recommended with confidence almost anywhere in New Zealand.

Great Scot.—Another variety which has performed quite well throughout the trials. It did not crop so heavily in relation to other varieties in Otago and Southland as it did in other districts.

Majestic.—Yielded moderately well in half the trials, but has not come up to expectations. The cooking qualities are excellent. The tubers are well shaped and have a good appearance.

King Edward.—It has been generally considered that this variety should be confined to Otago and Southland, where it scored heavily in marks for commercial possibilities, but elsewhere reports indicate that it was not at all popular in commerce.

Second-early Varieties :—

Ally.—This variety is not well-known in New Zealand, although it gained first at eight centres and second at three. Its cooking qualities are perhaps not the best.

British Queen.—Yielded consistently. dropping below third place in this

group only twice in the sixteen trials. Cooking qualities are highly satisfactory, and taking all points into consideration it is perhaps one of the best all round second-early varieties.

Sharp's Express.—The yield has not been satisfactory, and its pale lemon-coloured flesh is a disadvantage in view of popular prejudice.

First-early Varieties :—

Epicure.—This is generally regarded as the standard early variety for New Zealand. It gained first or second place in seven trials and last in three.

Early Puritan.—This variety performed quite well, being first or second in nine trials and less in two.

Duke of York did not yield well, being last in six trials. The flesh is lemon-coloured and would not be popular.

Herald.—Yielded very poorly, being last in eight of the trials. The cooking qualities are satisfactory.

Attention is drawn to the fact that in the early and second-early groups there was no variety which showed outstanding merit. Perhaps the most promising were Ally and British Queen as second-earlies, and Early Regent and Epicure in the first-earlies. The introduction of Arran Banner was a notable addition to the list of suitable varieties.

SOILS.

Nitrogen as a Manure for Meadows. *Hugo Osvald. Svenska Mosskulturforeningens Tidskrift.* 1931. 44, 3-84.—A series of plots was laid out in 1926 on a 13-year old pasture at the experimental farm Flahult to observe the effect of some nitrogenous manures and the time of their application on old peat land pastures. The experiments were continued over a period of four years, the yearly manurial treatment per acre being 1¼ cwt. 40 per cent. potash salts, 1¼ cwt. basic slag (1925-26) or superphosphate (1927-28), and 35 lb. nitrogen. The nitrogen was applied in three forms—sulphate of ammonia, cyanamide and nitrate of lime. The potash and phosphate were given in the autumn, whilst the application of nitrogen took place (1) complete addition in spring, (2) complete addition in summer, and (3) half in spring and the other half in summer.

The results show that the best nitrogenous manure was sulphate of ammonia, and that the most suitable time of application was in spring just after growth had commenced. The application of nitrogen had no influence on the chemical composition of the grasses, whilst the different nitrogenous manures had no effect on the botanical composition of the various plots. Under treatment meadow foxtail and smooth-stalked meadow grass increased and meadow and red fescues decreased.

No after effects of the nitrogenous manures was observed.

Sand Dressings at Gisselas. *Hugo Osvald. Svenska Mosskulturforeningens Tidskrift.* 1931. *44*, 317-328.—In 1922 a piece of peat land at Gisselas rich in lime and nitrogen was cultivated with a rotary tiller, afterwards being laid out in plots which were treated with sand in varying amounts and observed until 1929. The first crop, barley, was cut as green food, the plots in succeeding years being cropped as clover grass meadows. It was found that an addition of about 2,800 cubic feet of sand per acre produced a maximum increase which amounted to 16 cwt. hay per acre over the untreated plots. The cost of treatment was approximately *3s*. per cubic ft. of sand. The addition of sand was followed by an increased growth of clover and produced a better quality hay. The hay yield was greater in the warmer years.

Physical and Chemical Investigations on Danish Heath Soils. *F. Weis. Proceedings of Royal Danish Veterinary College*, 1932.—The investigations reported in this paper represent a continuation of a previous series published in 1929. The material used in the present paper was drawn from a virgin heath plain of late glacial origin in which all the soils are undisturbed. Determinations of the most important soil properties, which are of use in fixing the cultivation value of a heath, have been made. The biological characteristics are largely negative, and it is only after human interference that the soil can be made to bear higher plant life. For heath soils lime brings about the desired changes in the biological characteristics, brings in suitable bacteria, earthworms, larvæ and so on. The decomposition of the organic remains then proceeds in the manner best suited to the development of higher plants.

A different problem was presented by the drift sand area, but here again a thorough study from the physical and chemical point of view threw the desired light on the matter. Cultivation of green manures for two years, application

of fertilizers and subsequent planting in the third year gave a soil which in the course of six years was able to support a well-growing stand of white alder and Japanese larch Comparison of limed and unlimed areas shows that the limed area supports by far the more luxuriant growth The question of afforestation on soils of this nature seems to have been solved by the method used here.

DAIRYING.

The Vitamin A, B (B_1) and G (B_2) Contents of Milk throughout the Year. *By Florence L MacLeod, Jessie B. Brodie and Emily R. Macloon.* 1932 *Jour Dairy Sci , Vol* 15. *pp* 14 22—It would appear that heredity plays but little part in the vitamin content of the milk of cows, which largely depends upon the nutrition of the individual animal The present experiment deals with a herd of cows stall fed throughout the year. The milk from these cows was fed to rats, and it was found that the vitamin A value of the milk was comparatively constant from season to season, and much the same applied also to vitamins B (B_1) and G (B_2) Altogether the results indicate that milk which is produced under excellent conditions of stall feeding is uniform and a good source of vitamins A, B (and G (B_2)

Inheritance of Milking Capacity. *By Karl Madsen* 1932. *Nature Jan. 30th, pp.* 165 *and* 166—With a view to studying the importance of different bulls as measured by the production of their progeny the author correlated the yields of the daughters of a large number of bulls of the Red Danish breed to the yields of their dams and grandams and to the yields of the daughters of their sires and grandsires He has worked with a fairly large number of animals In most cases there were over 500 bulls correlated to a particular ancestor, and the average number of daughters to each bull was eighteen The yields were corrected for age &c He finds a highly significant difference between the correlation figures of the bulls to the yields of their grandams, that to the paternal grandam being practically *nil*, while that to the maternal grandam is significant This is in distinction to the correlation of the yields of cows to their paternal grandams which are as high as to their maternal grandams, but it is in accord with the view that some of the factors governing the inheritance of milking capacity are transmitted in a sex linked manner

ANIMAL BREEDING.

Cattle

The Periods of Embryonic Growth in Cattle. *By D I Kislotsky and B A. Larchin* 1931 *Jour Agri Sci Vol* 21, *Part* 4 *pp* 659 668—This is an interesting paper in which the authors claim to have demonstrated that there are, after forty days from conception five periods of growth in the calf, and that these periods vary according to the breed The well developed dairy breeds pass the last break in the rate of growth before birth, while all others have one, and some as much as two, after birth

ANIMAL NUTRITION.

Cattle

Feeding Raw and Ensiled Potatoes to Ruminants. *Lüthge Süddeutsch landwirtsch Tierzucht*, 1931 25 412 414—Potatoes may be fed raw to milk cows Steaming does not improve utilization, but costs are increased by at least 20 pfg per ctr The most suitable quantity for milk cows is 15 kg. raw potatoes Bigger quantities say 17 20 kg should be fed only if there is a large surplus of potatoes A ration of 15 kg potatoes, 5 kg hay, 4 kg. straw and 2 kg soya bean meal and earth nut cake is sufficient for 15 litres milk Working oxen and fully grown fattening animals may be given 20 kg raw potatoes Potato silage is not so suitable for milk cows since it is too dear and can be better used in pig feeding Steamed potatoes give good results with young bullocks They will consume 11 kg daily or 15 kg of potato silage On a ration of 3 5 kg feeding beet, 2 3 kg hay, 1 2 kg oil cake and 100 g fish meal, gains are excellent For sheep 1 to 2 kg raw potatoes form a good basal ration, and steamed potatoes are well suited for fattening lambs

Feeding Potatoes to Dairy Cattle. *K Richter Deutsch landwirtsch. Presse*, 1931, 58, 509 *(Prussian Res Inst for Animal Nutrition and Breeding)*—A survey is given of experiments at the Nutrition Institute for the Tschechnitz station on the feeding of raw and ensilaged steamed potatoes. It was shown that potatoes in either form may be introduced into the ration in amounts up

to 15 kg. per head per day. About 40 kg. beet and some of the concentrates may be replaced by potatoes in this way and a satisfactory utilization of the potatoes secured. Even when fed for a long time there were no harmful effects.

Calf Rearing on Milk-selling Farms. *J. Mackintosh, J. Brit. Dairy Farmers' Assoc.*, 1931, *43*, 9-26. (*Nat. Inst. Res. in Dairying, Reading.*)—The results of several years' experience of feeding calves on different cake and meal mixtures and on different amounts of milk are reported. The composition of the calf meals was based on the composition of milk and the palatability of the ingredients. Analyses and costs of the various calf meals are given. The results show that calves can be reared successfully to six months of age on about 30 to 40 gallons whole milk, 3 to 3½ cwt. cake and meals and 5 to 6 cwt. good hay.

Raising Calves on Dry Calf Meals. *I. R. Jones, P. M. Brandt and F. D. Wilson. Agric. Exp. Stat., Oregon State Agric. Coll., State Bull. No.* 290, *June* 1931. (12 figs., 6 plates, 4 refs.)—Experiments were conducted (1) to determine the earliest age at which calves can be weaned and the minimum amount of whole milk and skim milk necessary to obtain normal growth; (2) to determine whether it is possible to raise on a ration of dry meals, hay and water calves weaned at six months old; (3) to compare three different dry calf meals, and (4) to determine the costs of rearing calves to six months old on the various systems. The results showed that calves can be successfully weaned at from 30 to 50 days old on about 160 lb. whole milk and 90 lb. reconstituted skim milk. A small amount of milk fed over a longer period is preferable to the same amount fed over a shorter period. The average cost of rearing a calf to 196 days old was $18·38, with an average daily gain of 1·24 lb. The use of a dry calf meal reduced the average cost in practice of feeding a calf to 180 days old by $10-$15. In addition the system required less labour.

Pigs.

Plant Protein in Rapid Fattening of Pigs on Potatoes. *W. Stahl, A. Göhner and F. Barth. Deutsch. landwirtsch. Tierzucht*, 1931, *35*, 650-653. (*State Exp. Stat. for Pig-keeping, Ruhlsdorf, Teltow.*)—Three experiments each with three comparable groups of 8 young pigs, and a fattening experiment on 7 young pigs with an oil cake mixture, were made to determine in what amounts plant protein (as oil cake) may replace animal protein. From all three experiments, which were made with sunflower cake meal, soya bean meal and earth nut meal, it appeared that in feeding potatoes to young pigs up to a weight of 50 kg. half animal and half plant protein may be given, if at least 100 g. fish meal is given. In pigs over 50 kg. weight fish meal may be reduced to not less than 50 g. The fattening experiment in which a mixture of oil cakes only was fed showed diminished appetite, poor gain in weight, increase in fattening time, food wastage and increased cost of production.

Experiments with Skimmed Milk. *J. Jespersen and Fr. H. Petersen. 141st Rep. Res. Lab., Roy Vet. and Agric. Coll., Copenhagen*, 1931, *pp.* 81.—On the basis of three years' experiments on pigs to determine the production value of milk as sole protein supplement to a ration of barley, maize and wheat, the conclusion is drawn that the best results are got when young pigs receive 100 g. digestible true protein per feed unit, decreasing to 80-85 g. for older pigs. To ensure this amount, 2 kg. milk per kg. cereals should be fed from 25 to 45 kg. weight, 1·5 kg. milk from 45 to 65 kg. weight, and 1·0 kg. milk per kg. cereals from 65 kg. onwards.

The addition to this ration of a mineral mixture consisting of 52 per cent. chalk, 30 per cent. bone meal, 8 per cent. salt (NaCl) and 10 per cent. secondary sodium phosphate, and fed at the rate of 8 g. per pig daily, gave no improvement in rate of growth over the milk and cereal ration.

The Value of Tapioca Flour and Sago Pith Meal in the Nutrition of Swine. *H. E. Woodman, A. W. M. Kitchin and R. E. Evans. J. Agric. Sci.*, 1931, *21*, 526-546. (8 *refs.*) (*Inst. Animal Nutrition, School of Agric., Cambridge.*)—Feeding trials and digestibility trials with pigs on two carbohydrate foods—tapioca flour and sago pith meal—are described. The tapioca flour showed good results, and not only did it possess a high coefficient of digestibility of N-free extractives (98·54 per cent.), but it also increased the digestibility of the N-free extractives of the other foods in the diet. The feeding trials showed that it could be used to replace 20 per cent. of barley meal in a ration for young

pigs or 40 per cent. for older pigs (over 140 lb. live weight). It also had a beneficial effect on the carcases.

Sago pith meal depressed the digestibility of the protein supplied in the rest of the ration and supplied none itself. Feeding trials showed that it could replace barley meal up to 20 per cent. of the ration. Using more than this in a ration gave poor results

The Effect of Barley in the Ration on the Quality of Bacon. *D. J. Schutte and C. A. Murray 17th Rep. Director Vet. Services and Animal Ind., Union of S. Africa, August* 1931, *pp.* 813-817. (1 *fig.*, 5 *refs.*) (*Onderstepoort, S. Africa.*)—Replacing maize meal with barley meal to the extent of 45 per cent. of the ration in a ration of 90 per cent. maize meal and 10 per cent fish meal had the effect of increasing the rate of growth of pigs and producing a greater number of higher grade, longer and firmer carcases. Increasing the percentage of barley meal to 70 per cent. showed no additional benefits.

The Causes of Soft Pork. *W. L. Robison. Ohio Agric Exp. Stat. Bimonthly Bull No.* 152 (*Sept.-Oct.* 1931), *pp* 184-189.—Soft pork is most likely to be produced by feeding foods with a high oil content. This fact accounts for the softness of pork produced by feeding soya beans, though the extracted soya bean produces a much firmer carcase. Rapidly growing pigs have a tendency to greater firmness than slow growing ones, and short (chuffy) pigs will kill out firmer than long lean (rangy) ones.

Poultry.

Importance of Mineral Supplements, especially of Calcium for Chicks and Laying Hens. *W. Kupsch Geflugel Ztg.*, 1931, *34*, 689-694 (*Exp. Poultry Farm of Deutsch landwirtsch. Geflugel Ztg.*)—For chicks and laying hens the calcium and phosphoric acid ratio in the food should be 3 · 1 to 4 · 1. For chicks a mineral mixture of 2 parts steamed bone flour, 1 part oyster shell and 1 part salt (NaCl) should be fed to the extent of 3 per cent. of the dry matter of the ration, with the addition in winter or during the indoor feeding of 20 g cod liver oil or one drop vigantol for 20 chicks Calcium chloride is also suitable for chicks, inorganic phosphates to be avoided For laying hens 3 to 5 g calcium carbonate per head per day is recommended. Addition of this amount to a cereal, fish meal ration increased egg production by 5 per cent

Studies in Hatchability: 6. Hatchability in relation to Current Egg Production. *M. A. Jull Poultry Sci*, 1931, *10*, 327 331 (7 *refs.*) (*Bur. Animal Ind., U S Dept. Agric*)—Data available for the years 1925 to 1930 at the U S. Animal Husbandry Experimental Farm, Beltsville, were used to determine the influence of egg yield on hatchability. Egg yields of birds of different breeds were classified into two groups according to whether they fell above or below 20 during a standard 50 day period The mean percentage hatchability of these groups was then determined It was found that, after eliminating the influence of different males, high egg yield during the breeding season was favourable to high hatchability

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in December 1931, and January and February 1932.

Live Stock : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters)

Description	December			January			February		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK —									
*Cattle —	per cwt s d	per cwt s d	per cwt s d	per cwt s d	per cwt s d	per cwt s d	per cwt s d	per cwt s d	per cwt s d
Aberdeen Angus	55 7	47 3	42 0	55 2	47 3	42 0	52 3	44 11	43 6
Cross-bred (Shorthorn)	51 5	43 5	34 9	50 4	43 9	34 3	47 10	42 3	34 4
Galloway	48 5	43 2	40 0	47 3	43 0		46 3	42 2	
Ayrshire	43 7	37 2	31 10	45 0	37 0	31 4	40 9	34 6	29 8
Blue Grey	55 0			48 6					
Highland	43 0								
	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d
†Veal Calves	15	9		15	8½		15½	8¼	
	Hoggs under 60 lb	60 lb and upwd	Ewes	Hoggs under 60 lb	60 lb and upwd	Ewes	Hoggs under 60 lb	60 lb and upwd	Ewes
†Sheep —	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d
Cheviot	9½	7¾	6½	9½	7½	6¾	9½	7¾	7
Half bred	9½	8	6	9¼	8	7½	9½	8¼	6½
Blackface	9¾	8¼	6¾	9¾	8¼	7	9¾	8	7¼
Greyface	10	8½	6	9¾	8¾	6	10	8¾	6¾
Down Cross	10	9¼	5¾	9¾	9	6	9¾	9	6¾
†Pigs —	per stone s d	per stone s d	per stone s d	per stone s d	per stone s d	per stone s d	per stone s d	per stone s d	per stone s d
Bacon Pigs	8 6	7 8		8 3	7 6		8 5	7 10	
Porkers	10 1	8 10		10 0	9 2		9 11	9 2	

* Live weight † Estimated dressed carcase weight

Live Stock: Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	December.			January.			February.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK:—									
CATTLE—									
Aberdeen-Angus:	Per head. £ s.	Per head. £ s.	Per head £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head £ s.	Per head £ s.	Per head £ s.
Yearlings	15 12	12 0	11 5	15 18	12 2	...	15 8	11 2	...
Two-year-olds ...	20 18	16 11	..	20 9	16 17	...	20 7	16 14	...
Cross-bred (Shorthorn):									
Yearlings	14 13	10 14	.	14 7	10 16	...	14 8	10 14	..
Two-year-olds ...	19 13	15 10	...	19 1	15 11	...	19 17	15 16	...
Galloway:									
Yearlings	12 19	11 5	...	14 12	...	...	13 9	...	...
Two-year olds ..	..	13 10	..	...	16 10	...	..	16 0	...
Ayrshire:									
Yearlings	..	...	..	14 5	...	..	...	...	...
Two-year-olds ...	..	..	...	...	...	..	...	...	..
Blue Grey:									
Yearlings	...	...	..	...	..	...	...	...	...
Two-year-olds ...	..	...	..	...	...	...	.	...	...
Highland:									
Yearlings	..	.	.	...	...	...	...	...	...
Two-year-olds ...	.	.	...	...	...	...	...	..	...
Three-year-olds ..	...	...	...	...	...	...	...	...	...
DAIRY COWS—									
Ayrshire:									
In Milk	28 10	21 19	12 5	25 3	18 14	12 0	24 12	16 18	11 0
Calvers	28 3	20 7	14 15	26 19	19 9	14 0	26 18	18 18	13 16
Shorthorn Cross:									
In Milk	31 15	24 9	...	29 15	22 17	...	29 3	21 7	20 0
Calvers	30 12	21 14	16 12	29 5	20 11	14 17	27 18	20 4	14 17
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ..	...	.	...	...	...	..	21 9	16 0	...
Half-bred Hoggs .	30 0	...	...	38 8	33 0	...	36 5	25 9	...
Blackface Hoggs ..	22 2	15 10	...	21 9	16 3	...	25 3	17 3	...
Greyface Hoggs ..	31 2	23 1	...	31 0	22 0	...	33 1	24 10	...
Down Cross Hoggs	29 6	23 4	...	33 7	30 3	...	35 11	...	..
PIGS—									
(6 to 10 weeks old)	20 4	12 1	...	22 8	13 3	...	24 9	14 5	...

Dead Meat: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	December. Dundee.	December. Edinburgh.	December. Glasgow.	January. Dundee.	January. Edinburgh.	January. Glasgow.	February. Dundee.	February. Edinburgh.	February. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Beef:—										
Home-fed—										
Bullock or Heifer ...	1	8⅝	8	9¼	8¼	7¾	9⅜	8⅛	7⅞	9
	2	7⅞	...	7⅝	7½	...	7½	7½	...	7½
Bull	1	6⅝	5⅞	6¼	6¼	6	6	6⅛	6	6
	2	5⅞	...	5¼	5½	...	5	5½	5½	5
Cow	1	5⅜	5⅛	5¼	5	5⅛	5⅜	5¼	5⅛	5½
	2	4⅞	...	3½	4½	...	3½	4¾	...	3½
Irish—										
Bullock or Heifer ...	1	...	...	7½	...	...	7⅝	...	...	8
	2	...	...	6½	...	...	6½	...	...	6⅝
Argentine Frozen—										
Hind Quarters ...	1	4½	6¼	...	4⅛	6⅛	...	4⅜	5½	..
	2	4	3⅞	...	...	3⅝	...	4	3¾	...
Fore "	1	3⅜	3⅜	.	3⅛	3⅛	...	3⅛	3½	..
	2	..	2¾	..	...	2⅛	...	...	2¾	...
Argentine Chilled—										
Hind Quarters ...	1	6⅝	6½	6¼	6¼	6	6⅛	5⅞	5½	6⅜
	2	6⅛	5⅞	5¼	5¼	5⅛	5⅛	...	5	5⅜
Fore "	1	3¾	3½	3¼	3½	3⅜	3⅛	3¾	3¾	3⅝
	2	3½	3⅛	3	3¼	2¾	2¾	...	3¼	3⅜
Australian Frozen—										
Hind Quarters ...	1	...	...	4	...	...	3⅞	...	...	3⅝
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	..	3	...	...	2⅞	...	...	2⅜
New Zealand Frozen—										
Hind Quarters ...	1	..	...	4	...	...	3⅞	...	...	3⅝
	2	..	...	...	...	...	..	...	...	...
Fore "	1	...	..	3	...	...	2⅞	...	...	2¼
	2	...	...	...	...	...	...	...	.	...
Mutton:—										
Hoggs, Blackface ...	under 60 lb.	10⅜	8⅝	9	9½	8	9¼	8¾	7⅞	9¼
	60 lb. & over	9⅜	.	8⅝	8½	...	8¼	8⅛	...	8⅝
" Cross	under 60 lb.	10⅜	8⅝	9	9½	8	9¼	8¾	7⅞	9¼
	60 lb. & over	9⅜	.	8⅝	8½	...	8¼	8⅛	...	8⅝
Ewes, Cheviot	1	...	5⅛	5¾	. .	5	6⅜	...	6	7
	2	...	...	5⅛	...	4¾	5⅝	...	..	6⅜
" Blackface ...	1	6¾	5⅛	5¾	6	5	6⅜	6⅜	6	7
	2	5¾	...	5⅛	5	4¾	5⅝	5¾	...	6⅜
" Cross	1	4¾	5⅛	5¾	4	5	6⅜	5½	6	7
	2	...	...	5⅛	...	4¾	5⅝	5	...	6⅜
Argentine Frozen ...	1	...	...	4⅛	..	...	4	...	..	3¾
	2	...	...	...	...	.	...	...	...	...
Australian " ...	1	...	4⅛	3⅜	...	4⅛	3⅜		4½	3½
	2	...	3⅛	...	...	3	...		3¼	...
New Zealand " ...	1	...	...	4⅜	. .	...	4¼	.	..	3⅜
	2	...	...	4⅛	...	...	3⅞	...	. .	3⅜
Lamb:—										
Home-fed	1	...	...	9¼	...	..	9¼	..	..	9¼
	2	...	...	8¾	..	...	8¼	...	...	8¾
New Zealand Frozen ...	1	...	7½	7⅛	...	6⅛	7	...	7½	7
	2	...	5¾	...	...	5½	6⅛	...	5½	6⅛
Australian " ...	1	...	...	6¼	...	...	6	...	...	5⅝
	2	...	...	...	...	...	...	...	.	...
Argentine " ...	1	...	...	5½	..	...	5½	. .	...	5⅛
	2	..	...	...	...	...	..	...	...	..

Eggs: Monthly Average Wholesale Prices at Aberdeen and Glasgow. **Provisions Monthly Average Wholesale Prices at Glasgow.**

(Compiled from Returns received from the Department's Market Reporters.)

Market.	Description.		Quality.	December s	December d	January s	January d	February s	February d
Aberdeen	Country	per doz	1	2	1	1	7	1	2
			2	2	0	1	6	1	1
	Duck	,,	1	2	1	1	7	1	3
			2	2	0	1	6	1	2
Glasgow.	Country	per doz	1	2	2	1	10	1	6
			2	2	0	1	7	1	4
	Irish	per 120	1	20	11	17	5	13	8
			2	18	10	15	11	12	9
	,, (Cold Stored)	,,	1	12	6				
	,, (Duck)	,,	1	15	4	14	10	13	0
	American	,,	1	12	6	14	6		
	Argentine		1	12	0	13	0		
	Australian		1	14	1	13	8		
	,,	,,	2	13	6				
	Belgian	,,	1	15	6	13	3	10	10
	Canadian	,,	1	13	1				
	Chinese (Duck)	,,	1	9	9	9	2		
	Danish	,,	1			13	2		
			2			9	4		
	Dutch	,,	1			12	0	13	6
	Polish ..	,,	1	9	8	9	2	8	4
	,,	,,	2	8	4	8	6	6	8
	,, (Stored)	,,	1	8	7				
	,, ,,	,,	2	7	4		.		

Description.		Quality	December s	December d	January s	January d	February s	February d
BUTTER								
Irish Creamery	per cwt.	1						
,, ,, (Unsalted)	,,	1						
Australian	,,	1	108	7	104	6	108	9
Danish	,,	1	136	10	125	9	140	3
,, (Unsalted)	,,	1	141	10	130	9	145	0
New Zealand	,,	1	109	7	104	9	110	0
,, (Unsalted)	,,	1	116	5	117	6	120	0
Siberian		1	105	7	105	9	108	3
Swedish	,,	1	134	0	121	3	131	9
CHEESE								
Cheddar	,,	1	88	5	87	6	86	0
	,,	2	85	2	82	6	78	9
Cheddar Loaf	,,	1	98	0	98	0	100	0
,, ,,	,,	2	95	2	96	0	98	0
Dunlop	,,	1	88	10	89	9	94	0
,,		2	86	0	85	0	89	9
Canadian	,,	1	75	7	76	0	76	0
New Zealand (Coloured)	,,	1	68	0	62	3	67	6
,, (White)	,,	1	69	0	64	0	69	6
HAMS.								
Irish (Smoked)	,,	1	127	0	127	0	127	0
,, ,,	,,	2	114	0	114	0	114	0
American, Long Cut (Green)	,,	1	72	7	72	0	75	9
,, Short Cut	,,	1	74	0	76	9	75	3
BACON								
Ayrshire (Rolled)	,,	1	93	0	97	0	98	6
Irish (Green)	,,	1	65	2	78	6	88	0
,, (Dried or Smoked)	,,	1	73	2	85	6	94	0
,, (Long Clear)	,,	1	74	10	86	0	80	6
Wiltshire (Green)	,,	1	88	0	96	0	98	6
,, (Dried or Smoked)	,,	1	94	0	102	0	104	6
Danish, Sides	,,	1	53	10	57	0	57	0
Dutch, Green (Wiltshire Style)	,,	1	50	10	54	0	51	6
Polish, Green ,, ,,	,,	1	49	0	50	6	48	3
American (Long Clear Middles - Green)	,,	1	.		...		.	
American (Short Clear Backs)	,,	1					..	

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.		Quality.	DECEMBER.	JANUARY.	FEBRUARY.
FRUIT:—					
Apples—			s. d.	s. d.	s. d.
American ...	per case.*	1	13 6	13 4	12 10
,, ...	per barrel †	2	23 2	24 7	26 2
Pears, Californian	per case.*	1	18 0	15 8	17 0
VEGETABLES:—					
Beet .. .	per cwt.	1	10 4	12 6	11 6
Brussels Sprouts .	,,	1	12 0	12 0	10 6
Cabbage, Coleworts ..	per doz.	1	1 6	1 2	1 0
,, Red	,,	1	3 0	2 11	2 8
,, Savoy	,,	1	1 9	1 11	1 9
Carrots, .	per cwt.	1	6 0	7 2	7 2
Cauliflowers—					
Broccoli, Cornish	per doz.	1	4 0	5 0	4 10
French ..	,,	1	4 0	4 9	5 3
Celery	per bunch	1	2 1	1 10	1 8
Cucumbers ..	per doz.	1	6 0	.	
Greens	per doz. bunches.	1	8 0	6 0	5 9
Leeks ..	,, ,,	1	2 5	2 9	2 8
Lettuce, Cos (*Imported*)	per doz.	1	3 6	...	.
,, Cabbage ,,	,,	1	§1 0	3 11	3 11
Onions, *Spring* .	per bunch.	1	0 6	0 6	0 6
,, *Dutch* .	per bag ‡	1	9 2	13 2	12 8
,, *Valencia*	per case.†	1	10 6	11 8	13 2
Parsley . .	per cwt	1	12 0	11 0	16 0
Parsnips	,,	1	8 0	7 9	7 9
Radishes	per doz. bunches.	1	1 11	2 0	2 0
Rhubarb . .	per cwt.	1	46 0	34 0	32 0
Spinach	per stone.	1	3 5	4 0	4 0
Tomatoes—					
Scottish, National mark, "A. A"	per lb.	1	0 7¾		...
,, ,, ,, *Medium*	per lb.	1	0 7¼		..
Other Scottish ...	,,	1	0 7	.	...
Channel Islands ...	,,	1	0 2¾	0 6¼	0 4¼
Canary	,,	1	0 2¾	...	...
Turnips	per cwt.	1	2 3	2 2	2 0

* 40 lb. (approx.). † 9 stone (approx.). ‡ 7½ stone (approx). § Home-grown.

POTATOES : Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(*Compiled from Returns received from the Department's Market Reporters.*)

MARKET.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Golden Wonder.	Late Varieties. Other Soils. Other.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
DECEMBER.							
Aberdeen, per ton	1	...	...	...	...	9 4 0	7 3 6
Dundee ,,	1	...	...	...	...	...	7 8 6
Edinburgh ,,	1	...	8 6 0	...	...	11 2 0	8 6 0
Glasgow ,,	1	...	7 7 0	...	...	9 19 0	7 14 0
JANUARY.							
Aberdeen ,,	1	.	..	...	...	11 2 6	9 19 5
Dundee ,,	1	. .	..	...	...	..	10 7 6
Edinburgh ,,	1	...	...	...	...	11 10 0	10 7 6
Glasgow ,,	1	...	. .	...	...	13 5 0	10 2 6
FEBRUARY.							
Aberdeen ,,	1	...	. .	...	...	10 3 9	8 17 6
Dundee ,,	1	...	...	...	...		8 10 0
Edinburgh ,,	1	...	...	. .	11 5 0	11 7 6	9 13 9
Glasgow ,,	1	...	...	..	...	11 7 6	9 6 3

ROOTS, HAY, STRAW AND MOSS LITTER : Monthly Average Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(*Compiled from Returns received from the Department's Market Reporters.*)

MARKET.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
DECEMBER.										
* Aberdeen, per ton	1	...	...	...	55 0	...	..	..	41 3	...
‖ Dundee ... ,,	1	. .	17 5	21 11	90 0 *a* 80 0 *b*	...	68 0	...	68 0	55 0†
¶ Edinburgh ,,	1	...	...	...	72 6 *a* 65 0 *b*	...	46 0	35 0	15 0	...
‖ Glasgow ,,	1	...	...	...	60 0	65 0	45 0	...	42 0	32 6‡
JANUARY.										
* Aberdeen ,,	1	...	...	..	55 0	...	...	...	35 0	...
‖ Dundee ... ,,	1	...	14 0	19 3	90 0 *a* 80 0 *b*	.	70 0	...	70 0	55 0†
¶ Edinburgh ,,	1	...	...	...	72 6 *a* 65 0 *b*	...	47 6	...	45 0	..
‖ Glasgow ,,	1	...	...	...	60 0	65 0	45 0	...	42 6	32 6‡
FEBRUARY.										
* Aberdeen ,,	1	...	...	...	55 0	...	...	.	35 0	...
‖ Dundee ... ,,	1	...	12 0	16 6	90 0 *a* 80 0 *b*	...	65 0	...	65 0	55 0†
¶ Edinburgh ,,	1	...	...	...	72 6 *a* 65 0 *b*	...	47 6	37 6§	45 0	...
‖ Glasgow ,,	1	...	...	...	60 0	65 0	45 0	...	42 6	32 6‡

* Loose, ex farm.
‖ Straw, delivered baled.
¶ Straw, delivered bunched.

a Delivered baled.
b Delivered loose.

† Delivered in town.
‡ Home (in 1½ cwt bales).
§ Baled on rail.

FEEDING STUFFS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	December. Glasgow.	December. Leith.	January. Glasgow.	January. Leith.	February. Glasgow.	February. Leith.
	per ton £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	8 17 6	8 10 0	8 17 6	8 11 3	8 13 5	8 8 9
Foreign	8 5 6	7 15 0	8 1 3	8 0 0	8 2 6	8 0 0
Decort. Cotton Cake	7 10 0	...	7 14 5	...	8 0 0	...
Undecorticated do.— Egyptian	5 19 2	5 16 6	5 16 2	5 13 2	5 10 11	5 9 5
Palmnut Kernel Cake	8 0 0	...	8 3 9	...	8 5 0	...
Soya Bean Cake ...	9 6 0	8 5 0	9 5 0	8 5 0	9 5 0	...
Coconut Cake ...	8 5 0	...	8 9 5	...	8 10 0	...
Groundnut Cake, Undecorticated	...	8 0 0	...	7 16 8	7 0 0	8 0 0
Maize Germ Cake— Home	8 0 0	..	8 0 0	...	8 1 11	...
Maize Germ Cake Meal	6 8 0	..	6 0 0	...	5 18 9	...
Rice Meal	5 15 0	...	5 11 3	...	5 13 5	...
Bean Meal	8 15 0	9 0 0	8 18 2	9 2 6	9 8 2	9 5 0
Barley Meal .	7 10 0	7 8 9	7 13 2	7 10 0	7 18 9	7 11 8
Fish Meal	15 10 0	15 10 0	15 10 0	15 10 0	15 6 3	15 10 0
Maize Meal— Home-Manufactured	5 15 0	5 17 0	5 16 3	5 15 0	6 0 0	5 18 9
South African—(Yellow) . .	5 18 9	6 0 0	5 8 5	...	5 14 8	6 0 0
Locust Bean Meal (Fine)	6 14 0	6 0 0	6 16 11	6 0 0	6 19 5	6 0 0
Maize Gluten Feed (Paisley)	6 4 0	..	5 18 9	...	5 15 0	...
Maize— Plate	4 16 9	4 15 6	4 17 2	4 15 0	5 2 6	5 1 3
African, Flat ..	6 8 0	...	6 1 3	...	6 3 2	...
Oats— Home .	9 4 0	8 8 0	8 16 3	8 10 0	8 3 5	8 8 9
Plate	7 8 0	6 18 6	6 17 2	6 16 8	6 8 2	6 15 0
Canadian No. 3 .	8 2 0	...	8 1 11	..	8 1 8	..
Barley, Feeding (Home)	7 0 3	6 9 0	7 5 0	6 10 0	7 1 11	6 10 0
Wheat— Home	8 7 6	7 10 0	8 0 4	7 8 9	7 16 3	7 2 6
Poultry	7 4 0	...	7 5 0	...	7 3 9	...
Imported	7 14 0	6 11 3	7 12 6	6 9 5	7 10 8	6 8 9
Middlings (Fine Thirds or Parings)	6 19 0	6 13 0	7 0 8	6 10 8	7 5 2	6 13 9
Sharps (Common Thirds) ...	6 4 3	6 3 0	6 2 2	6 0 0	6 8 5	6 3 9
Bran (Medium) ..	5 18 3	6 1 0	6 1 7	5 17 6	6 8 9	6 7 6
,, (Broad) ...	6 1 3	6 19 0	6 2 10	6 16 3	6 9 1	7 2 6
Malt Culms... ..	5 8 9	4 17 6	5 14 1	4 15 0	5 18 2	6 0 0
Distillery Mixed Grains—Dried	...	7 7 0	..	7 14 4	7 11 8	...
Brewers' Grains— Dried	7 1 6	6 9 0	7 15 0	6 15 2	7 10 0	6 17 6
Distillery Malt Grains —Dried	8 0 0	...	8 7 6	..	8 7 6	...
Crushed Linseed ...	14 8 0	..	14 12 6	...	14 10 0	14 10 0
Locust Beans, Kibbled and Stoned	5 16 6	5 10 0	5 16 11	5 10 0	5 19 5	5 10 8
Beans— China	8 0 6	8 5 0	8 1 7	8 5 0	8 9 8	8 11 3
English	8 6 11	...	8 2 10	...	8 8 9	...
Rangoon (White)	6 15 0	...	6 17 6	...	7 1 3	...
Sicilian	8 5 0	...	...	...	...	...
Feeding Treacle ...	4 19 0	5 11 6	5 0 0	5 10 0	5 0 0	5 10 0
Linseed Oil, per gall.	0 3 8	..	0 3 0	...	0 3 0	0 2 3

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	December. Glasgow.	December. Leith.	January. Glasgow.	January. Leith.	February. Glasgow.	February. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda § ...	N. 15·5	8 12 0	...	8 14 0	...	8 16 0	...
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	6 16 0	6 14 0	7 0 0	7 0 0	7 0 0	..
Nitrochalk § ...	N. 15·5	7 5 0	7 5 0	7 5 0	..	7 5 0	...
Superphosphate ...	P.A. 13·7	2 7 6	2 12 6	2 7 6	2 12 6	2 7 6	2 12 6
,, ...	,, 16·0	2 12 6	2 17 6	2 12 6	2 17 6	2 12 6	2 17 6
,, ...	,, 18·3	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6
Ground Mineral Phosphate *a*	P.A. 26	2 7 6	...	2 7 6	...	2 7 6	...
,, ,, ,, *b*	,, 26	...	2 5 0	..	2 5 0	..	2 5 0
,, ,, ,, *a*	,, 34	3 7 6	..	3 7 6	...	3 7 6	...
,, ,, ,, *b*	,, 34	...	3 5 0	...	3 5 0	...	3 5 0
Potassic Mineral Phosphate	P.A. 18, Pot. 9	3 8 9	..	3 11 3	...	3 11 3	..
,, ,, ,,	P.A. 21, Pot. 6	3 3 9	.	3 6 3	.	3 6 3	...
Kainit (in bags) ..	Pot. 14	3 4 6	3 1 6	3 7 6	3 7 6	3 7 6	3 7 6
Calcium Cyanamide ‡	N. 20·6	6 15 0	...	7 0 0	...	7 0 0	...
Potash Salts ...	Pot. 20	3 13 9	3 10 0	3 18 9	...	3 18 9	...
,, ,, ...	Pot. 30	5 0 0	4 17 6	5 7 6	5 7 6	5 7 6	5 7 6
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	9 10 0	9 5 0	10 5 0	10 5 0	10 5 0	10 5 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 12 6	11 8 6	12 12 6	12 12 6	12 12 6	12 12 6
Steamed Bone Flour	N. 0·8, P.A. 28	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0
Bone Meal (Home)	N. 3·3, P.A. 22·9	6 15 0	..	6 15 0	..	6 15 0	...
,, ,, (Indian)	N. 4, P.A. 20	7 0 0	7 5 0	7 0 0	7 5 0	7 0 0	7 5 0
Basic Slag † ...	P.A 11	1 19 0	..	1 19 0	...	1 19 0	...
,, ,, ...	,, 12	2 1 6	...	2 1 6	...	2 1 6	..
,, ,, ...	,, 13	2 4 6	...	2 4 6	...	2 4 6	...
,, ,, ...	,, 14	2 7 0	*1 15 0	2 7 0	*1 15 0	2 7 0	*1 15 0
,, ,, ...	,, 15·75	2 11 0	*2 0 0	2 11 0	*2 0 0	2 11 0	*2 0 0
,, ,, ...	,, 16·5	2 14 0	...	2 14 0	...	2 14 0	...
,, ,, ...	,, 17·5	2 18 0	...	2 18 0	...	2 18 0	...

Abbreviations: -N. = Nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

§ Carriage paid, in 6-ton lots. ‡ Carriage paid, in 4-ton lots.
a Fine grist: 90 per cent. fineness through prescribed sieve.
b Fine grist: 85 to 90 per cent. fineness through standard 100 mesh sieve.
† Prices for Basic Slag at Glasgow—F.o.r., in 6-ton lots, 80 per cent. citric soluble.
* F.o.r., Grangemouth.

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LAND SETTLEMENT IN SCOTLAND.—I.

History.—In considering the subject of Scottish land settlement a distinction must be made between the Highlands and Islands and the rest of Scotland. The two areas differ in many respects, geographically, historically, economically, and socially.

Except in Caithness and the Black Isle in Easter Ross, arable farms in the Highlands are few. The mountains are mainly deer forests, the glens are occupied by large sheep farms on the edges of which, and round the seaboard, cluster crofting townships whose characteristic feature is the croft with a stance for house and byre, a small patch of arable to provide winter-feed for a cow or two, and a common grazing where the sheep and cattle owned by the members of the township find sustenance. Recurrent famines and the disorder attendant on them offered frequent reminders that the condition of the Highlands required amelioration, but it was not till 1883 that public interest was roused to such an extent that a Royal Commission was appointed to make an inquiry. Three years later the first Act of Parliament to deal with Highland agrarian problems was passed —the Crofters Holdings (Scotland) Act, 1886.

Under this Act crofters were given the rights of security of tenure, fair rent, and compensation for improvements, and the Crofters' Commission was appointed to deal with questions relating to crofters' tenancies and to grant enlargements. This, the first inroad into the field of land settlement, was largely ineffective owing to the absence of funds to pay compensation to landlords and tenants of lands proposed to be taken for enlargements, and to the lack of power to form new holdings. The long-standing agitation for more land broke out in the nineties with fresh intensity all over the Highlands. Attention was directed to large areas of grazing land in the deer forests which were being converted into sheep farms. Another Commission, appointed in 1892 to report on the suitability of such lands for closer settlement, scheduled large tracts of deer forest and sheep farm lands as suitable for new holdings and enlargements. Out of this enquiry came the Congested Districts (Scotland) Act, 1897, under which the Congested Districts Board with a fund of £35,000 per annum had power among other things to purchase and equip land for crofters, cottars and fishermen in the Congested Districts. As much as possible was done with the funds provided, but these proved too limited for any large scale operations.

Between 1886 and 1908 three additional Crofters Acts were passed. Two of these provided for the system so long practised in the Highlands under which a large area of pasture land is held in common by the crofters of each township. Owing to the size of his holding and the character of the soil and climate the crofter in the Highlands and Islands cannot normally depend entirely on the cultivation of crops. It is impracticable to enclose a separate small area of pasture land for each individual, and large areas of land are therefore necessary for grazing the township's cattle and sheep.

By the first decade of the twentieth century, the condition of the crofters in most areas was still bad, and the problem was complicated, particularly in the Long Island, by the presence of large numbers of cottars and squatters. Extensions were very naturally desired from the areas reserved for sport or devoted to sheep grazing. The demand for enlargements and for new holdings grew, and the agitation reverberated in the Lowlands. To meet the situation a further law—the Small Landholders (Scotland) Act—was placed on the Statute Book in 1911. The Board (now the Department) of Agriculture for Scotland and the Scottish Land Court were constituted to take the place of the Congested Districts Board and the Crofters Commission respectively. The privileges already afforded to crofters of fixity of tenure, fair rents, and compensation for improvements were extended to certain classes of smallholders throughout Scotland, the statutory limit of holdings being fixed at £50 rental or 50 acres, excluding any common pastures or grazing, except in the island of Lewis, where the previous limits of £30 or 30 acres for holdings in the crofting districts were still maintained.

One of the main duties of the Department under the new Act was the constitution of new, and the enlargement of existing, landholders' holdings. This could be done by agreement with landlords or, subject to a statutory procedure, by compulsion. In addition, all the powers and duties of the Congested Districts Board in the congested districts, including power to purchase properties for settlement purposes, were transferred to the Department. In putting schemes into operation the Department had authority to make loans for buildings and to offer grants or loans as they thought fit for the equipment and adaptation of land to be occupied by small holders. One of the first results of the new measure was to make known the large demand for settlement. Within nine months of the passing of the Act, the Department received over 5,000 applications for new holdings and enlargements. Progress under the Act was arrested by the war.

Four new measures, the Small Holding Colonies Acts, 1916 and 1918, the Sailors and Soldiers (Gifts for Land Settlement) Act, 1916, and the Land Settlement (Scotland) Act, 1919, were passed to provide a means of land settlement for ex-service men. The first two authorised the Department to acquire by agreement

a limited area of land for small holding colonies. These measures paved the way for the more important 1919 Act, which affected amendments in procedure, and provided a new means of financing operations by borrowings from the Public Works Loan Commissioners. Borrowings were authorised up to a sum of £2,750,000, increased under the Land Settlement Amendment Act, 1921, to £3,500,000. The powers and duties of the Department were extended so that land for subdivision could be acquired by agreement or compulsorily, and orders for the constitution of new holdings and enlargements on private estates could be made. Further, the Department had discretion to provide assistance for stocking the holdings formed. Authority to borrow money and to advance loans for stock purposes ceased on 31st March 1926. Since then land settlement in Scotland has been financed from the Agriculture (Scotland) Fund.

To the series of Landholders Acts was added the Small Landholders and Agricultural Holdings (Scotland) Act, 1931. At the same time there was placed on the Statute Book the Agricultural Land (Utilisation) Act, 1931, under which the Department were empowered to offer holdings to certain classes of applicants, including suitable unemployed persons without sufficient capital and experience, approved applicants being eligible to receive training, maintenance allowances and loans for stocking their holdings. Owing to the financial position of the country, the Government have not so far been in a position to provide funds for operating the Act.

Procedure and Development.—Since they began operations in 1912, the Department have often been criticised for not making greater progress with the settlement of applicants on the land. But it is not always recognised that there are factors in the situation over which the Department have no control and which militate against rapid development. The operations undertaken depend to a great extent on the policy of the Government of the day and on financial circumstances. It has not always been possible for successive Governments since 1912 to advance land settlement to the full limit of funds prescribed by statute. At present the country's financial condition governs the rate of progress. In the period succeeding the end of the war, land settlement, along with other services, came under the "Geddes Axe" of 1922, so that at 31st March 1926, when powers to borrow money ceased, the total sums which had actually been borrowed by the Department fell short of the provision of £3,500,000 by £1,342,000. At the same time the blow was softened by arrangements under which the Agriculture (Scotland) Fund was made available for land settlement and crofter housing exclusively. Owing to the need for national economy the rate of settlement of ex-service men had been slowed down considerably, and ex-service applications on the Department's register remaining to be dealt with at the time of cessation of borrowing powers numbered as many as 3,833.

Again, the procedure which has to be followed in order to

place men on the land is not simple and may not be curtailed. The 1911 Act was restricted in scope, and its limitations handicapped progress except at a very moderate rate. Remedies were to some extent provided by the Act of 1919, but procedure is still lengthy, and it is difficult to see how it can be simplified. To complete negotiations or statutory procedure for the acquisition of land suitable for subdivision, to secure vacant possession after negotiations or arbitration proceedings, to alter the rotation of the farms, to subdivide the land into small holdings, to erect new houses and steadings and partition off existing ranges of buildings, to provide all the other necessary equipment such as fences, roads and water supplies, and to have bonds and agreements signed by applicants, who must be carefully selected from the Department's crowded lists, are all operations which take time and must follow an orderly course.

Figure I shows the number of applicants settled in new holdings and enlargements in each of the past twenty years.

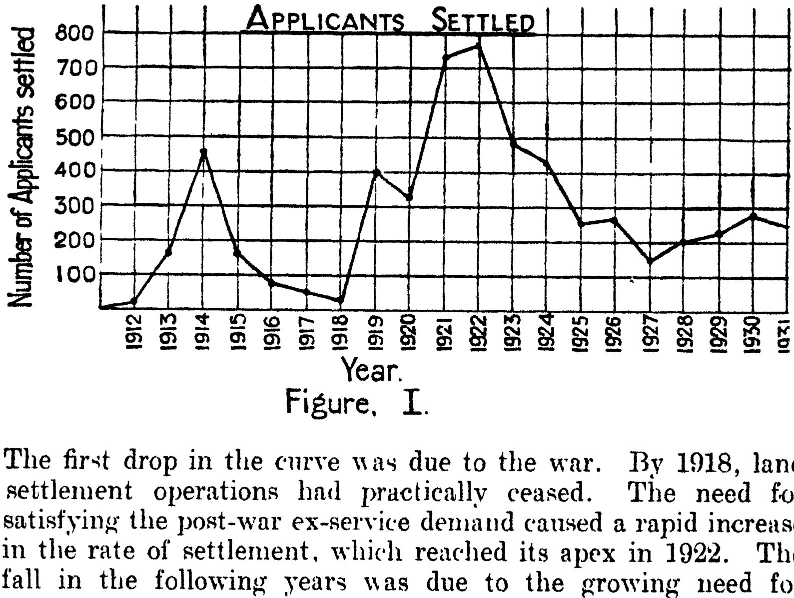


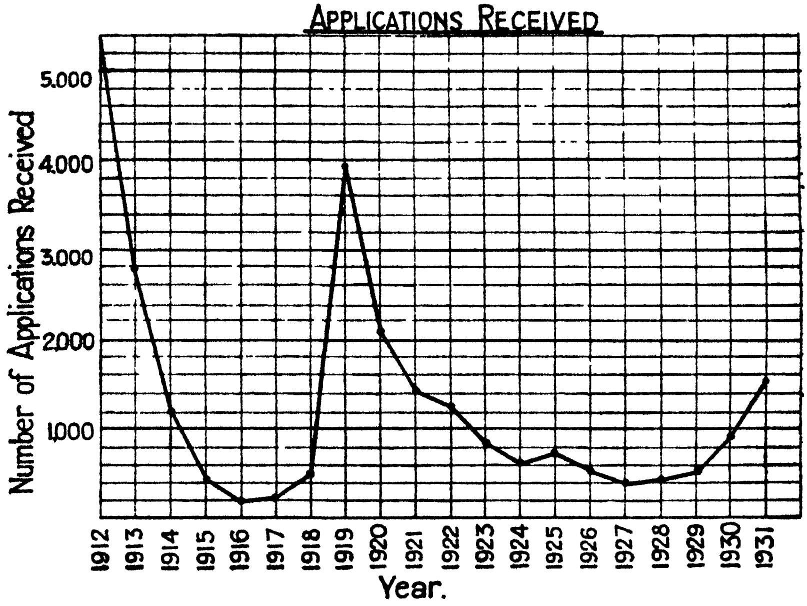
Figure. I.

The first drop in the curve was due to the war. By 1918, land settlement operations had practically ceased. The need for satisfying the post-war ex-service demand caused a rapid increase in the rate of settlement, which reached its apex in 1922. The fall in the following years was due to the growing need for national economy. The curve takes an upward turn towards 1930, and the 1930 rate of settlement would have been at least maintained had not the grave financial circumstances of the country in 1931 impeded progress and caused the rate to fall. The average number of applicants settled per annum throughout the twenty years was 295, including an annual average of 33 settled in holdings and enlargements constituted by the Department and vacated by the original tenants. In that period the Department settled 1,748 applicants in new holdings and 1,526 in enlargements on private estates; 2,217 in new holdings and 414 in enlargements on their own estates, i.e. 3,965 in new holdings and 1,940 in enlargements, a total of 5,905 settlements altogether. The area involved in these operations was 610,273

acres, and when there is added to this 205,341 acres subdivided by the Congested Districts Board and Crofters Commission, the total area of land in Scotland on which applicants have been placed since 1886 is found to be nearly 816,000 acres. A further area of 16,000 acres remains to be subdivided for about 300 applicants to complete the programme to which the Department are at present committed.

In 1912, the Department fell heir to six estates acquired by the Congested Districts Board. The Department now possess 107 estates covering 416,000 acres, with 3,600 separate tenancies and a rent roll (excluding annuity repayments of loans for buildings, sheep stocks and other purposes) of almost £58,000.

Demand.—Between 1912 and 1931, 24,897 applications were received by the Department. For various reasons 11,315 appli-



Figure, II.

cations were withdrawn and 5,905 applicants were settled in new holdings or enlargements. Accordingly, at the present time the Department's lists contain the names of 7,677 applicants waiting for access to land. These have various degrees of suitability for settlement, and perhaps about 25 per cent. of the total number of unsatisfied applicants whose names are on the register are definitely either unsuitable or have insufficient capital or experience. But there is a strong latent demand which would more than counterbalance the number of applicants on the Department's lists who may prove to be unsuitable.

In addition to the foregoing, about 1,000 applications under the Agricultural Land (Utilisation) Act, 1931, were received.

The graph in Figure II shows that large increases in the number of applications received coincided with the legislative

periods of 1911, 1919 and 1931. It will be seen that, owing to the war, few applications were received during the period 1915 to 1918. The demand by returning ex-service men accounted for the sharp rise in 1919 and the high figures for 1920 and 1921. 5,121 applications were lodged by ex-service men in the three years 1919 to 1921. The increase in the demand prior to 1931 corresponded with acceleration in settlement effected by the Department under Government instruction during the period. This tends to show that demand increases with the renewal of hope for settlement.

Of the 5,905 applicants settled in the past twenty years 4,188, or 70 per cent., were in the seven crofting counties, while of the 7,677 unsatisfied applications 5,573, or 72 per cent., come from these counties. It must not be inferred from these figures that land settlement is in much less demand in the Lowlands than in the Highlands and Islands, but the first main duty of the Department was to meet the more insistent demand from the latter area. Wherever land was available and it was practicable with the limited funds to open up the land, the demand was met. There is not now the same scope as formerly for settlement in the crofting counties, while the demand from the Lowland counties has during the past twenty years been gradually growing, and is continually reinforced whenever a specific scheme is undertaken and prospective applicants see in it a real opportunity of obtaining a holding. In the past five years 22 separate properties have been acquired for subdivision and five schemes have been developed on private estates in the non-crofting counties. The total number of settlements made was 313, while during the same period the demand for small holdings from the non-crofting counties has been more than doubled.

The 1919 Act gave ex-service men a preference over non-service applicants for a period of two years. Under Government direction the preference operated until 1926, and since then ex-service applicants are given the preference provided that their other qualifications are in all respects equal to those of non-service applicants.

Costs.—Even prior to the war, proprietors were becoming less able to apply to the land the capital necessary for its reasonable equipment. Few had sufficient reserves to undertake the remodelling of their estates on a small holding basis. When the need arose for forming small holdings and enlargements of existing holdings it was therefore necessary that the State should step in and undertake the burden of financing land settlement operations. The legislature recognised this in framing the various Acts passed since 1897.

The cost of land settlement is often a matter of discussion and criticism. Statements of initial gross or net capital cost of land schemes are misleading as an indication of the cost of land settlement to the State. It has to be borne in mind that some of the capital is recoverable, and that receipts accrue for varying.

periods of years which go to modify the cost to the taxpayer. A true view of the actual cost can therefore be obtained only by an actuarial valuation of all expenditure and receipts whether capital or otherwise. The Committee appointed in 1927 under the chairmanship of Sir J. G. Nairne, Bart., to inquire into land settlement in Scotland went closely into this subject, and found that on the valuation basis adopted the actual average net cost to the State of each holding or enlargement formed by the Department from 1912 to 1927 was £263 in the crofting counties and £841 in the rest of Scotland, or £399 for the whole country. They estimated that in the absence of any important modification of the economic conditions existing at that time the cost in the few years following 1927 would be £285 per holder for the crofting counties, £596 in other counties, and £360 for the whole country. The cost of a self-contained economic holding in the Highlands is about the same as that of a comparable holding in the Lowlands, but the inclusion in many Highland schemes of enlargements for the relief of populous townships reduces the average cost per holder settled. It is the Department's aim to enlarge the common grazings of Highland townships whenever and wherever practicable, but the opportunities for creating such enlargements become more restricted as time goes on. In fact, in some crofting districts, e.g. the Outer Hebrides, little land is left available for new enlargement schemes. It is probable therefore that, in proportion to the increase in the number of Lowland schemes, in which enlargements are unnecessary except in rare cases, the average cost per holder settled will be indicated by a figure approaching the Lowland standard of cost. The valuation carried out by the Committee showed that the average cost of small holdings provided in each case with buildings in the non-crofting counties was roughly £400 for holdings not exceeding 10 acres; £500 for holdings between 10 and 30 acres, and £1,000 for holdings exceeding 30 acres up to the limits of 50 acres or £50 of rent allowed by the Acts. These average costs include the whole cost of acquisition of the land or, where a scheme is formed on a private estate, the cost of compensating the owner.

No small proportion of the total expenditure on land settlement occurs on the provision of buildings, fences, roads and water supplies. From 1912 to date the sum of roughly £1,500,000 has been spent on these works, representing approximately 53 per cent. of the total capital expenditure made in respect of the schemes. The expenditure of this money has been a means of creating a demand for labour in the production of the materials used, in transport, and in the construction of the works.

The initial net capital cost of all the Department's schemes completed, in process of development, or not yet begun but to which the Department are committed is estimated to amount to roughly £3,300,000. This sum is allocated to the various heads of expenditure as follows :—

Acquisition and compensations	*£1,044,000*
Ingoings and management	346,000
Buildings	1,415,000
Fences, roads, water supplies and drainage	495,000
Total	£3,300,000

It is estimated that on the 31st March 1932 the outstanding balance of commitment, or the sum required by the Department to complete all the land schemes to which they are committed, amounted to over £450,000. During the two years to July 1931, a period of acceleration, the Department acquired 17 separate estates embracing about 18,000 acres and involving an ultimate expenditure, including acquisition, of £490,000. These properties cannot be wholly subdivided immediately they are bought, and a fair proportion of the outstanding balance of commitment represents expenditure yet to be made on the development of the estates recently acquired.

Financial assistance rendered by the Department towards the erection or adaptation of buildings is advanced to holders by way of loan and is recoverable in whole or in part. In the case of pastoral schemes loans are made to enable groups of holders to take over sheep stocks to be worked on the club or co-operative system. Generally, assistance for other purposes is by way of grant. During the past twenty years the assistance provided for buildings (including existing buildings) on land schemes and for the improvement of buildings of existing landholders and cottars amounted roughly to £1,435,000, while loans made to holders for taking over sheep stocks totalled £120,000. A large proportion of these loans yet remains to be repaid. Further loans amounting to about £8,000 were advanced to individual holders for the purchase of live stock, implements, seeds, &c. between 1919 and 1926, when the authority to make such loans ceased.

A.I.V. SILAGE.

From The Imperial Bureau of Animal Nutrition, Aberdeen.

In the conservation of the luxuriant summer production of green fodder for use as winter food for live stock, one of the most important considerations is that the process should ensure the maximum retention of the original nutritive qualities of the material preserved. Hay made under ideal weather conditions is an excellent food, but the unreliable climate and comparatively high rainfall of Northern European countries render it impossible to preserve grass in this way without impairing the original nutritive and vitamin content. This may reduce its value by as much as 50 per cent. Consequently investigation has been made into alternative methods, the most economical of which has

been the preservation of grass in the form of silage. Numerous and sufficiently well-known variants of this principle are practised, but most of them involve a certain loss in the nutritive value of the original material.

In a country like Finland where the summers are short, the provision of adequate supplies of nutritious winter food is of prime importance. In 1925, Dr. Artturi I. Virtanen, Director of the Research Laboratory of Valio, the large Finnish Co-operative Dairy Organisation, began an investigation into the preservation of grass in the form of silage, and he has now devised a technique by which he claims a conservation without fermentation and with all but an insignificant loss. To this process the name A.I.V. silage has been given, derived from the initials of the inventor. As the relative literature is scattered, and mostly in the Finnish language, the purpose of this note is to summarize, for the benefit of numerous enquirers, the existing information on the process.

Theoretical Basis of Method.—Virtanen started from the assumption that the conservation of green forage without noticeable loss is possible only when the splitting up of the nitrogenous material in the green forage by proteolytic enzymes is completely prevented. He had already observed that neither in the cells of higher plants nor in bacterial organisms themselves did there occur proteolytic enzymes capable of acting when the degree of acidity in the material attained a certain level, viz. lower than pH 4.[1] If, therefore, the degree of acidity in the green fodder is brought to the required standard in the conserving process, the breaking down of the nitrogenous substances is prevented. In laboratory experiments it was shown that acids such as hydrochloric acid, sulphuric acid, phosphoric acid, lactic acid, &c., could be homogeneously mixed with the fodder, and that by this means the acidity of the mass could be maintained at the necessary level. Since much larger quantities of weak organic acids than of strong mineral acids are required to obtain the same results, it became apparent that in practice the principal mineral acids would be most suitable. Laboratory trials proved that food preserved with hydrochloric acid was highly satisfactory from the bacteriological point of view in that no development of coli and butyric acid bacteria took place.

It is the attainment of the correct degree of acidity by the addition of acid which constitutes the essential feature of the method. Though it is generally accepted that hydrochloric acid is the acid which plays the chief part in the process, practical considerations have led to the use of a mixture of acids the exact composition of which is not known. This solution is termed the A.I.V. solution. The next step was to subject the method to practical tests on the basis of the laboratory experiments.

[1] The pH notation is used to measure the acidity in soils or other matter, the scale ranging from about pH 3·5 for acid to pH 9 to 10 for the most alkaline, the neutral being represented by pH 7. Thus the lower the pH index figures descend, the greater is the degree of acidity registered.

Application of the Method in Practice.—The standard type of A.I.V. silo is circular in shape, 16½ feet in diameter and 5 feet deep. A smaller type, 3 metres in diameter, is recommended on farms having less than 15 milk cows. The pit is dug somewhat wider than 5 metres to facilitate the construction of the cylindrical wall of planks, after which any empty space outside the wall is filled in with earth and stamped down. Sites, free from sub-soil water, on rising ground near the farmyard or crop to be ensiled, are generally selected. The bottom of the silo pit is levelled, and, where the soil is clayey, spread with a layer of clean gravel. No floor boards are used. Where possible a drain pipe should be laid from the centre in order to carry off the sour liquid which collects after the pit has been filled. If, owing to the presence of sub-soil water, the pit cannot be made deep enough, the walls may project above the ground, in which case earth must be banked up outside and covered with sods. If necessary, the silo can be erected entirely above ground and the wall of earth and sods piled up correspondingly high.

When finished, the pit is filled with fresh fodder (chopping up is unnecessary) spread as evenly as possible in lots of about 450 lb. at a time, and sprinkled with the A.I.V. liquid, which is measured out accurately in accordance with the directions supplied. This solution is poured from watering cans which have been previously coated inside with varnish or rubber. Each successive plot of 450 lb. is tramped down as evenly as possible, rubber boots being worn in preference to leather as the liquid gradually destroys the latter. When the pit is quite full, a closely-fitting circular upper section, constructed of planks 6½ feet long, is placed in position, and the filling-up proceeds as before until this upper section is also full to the brim. Clean boards are then placed on top in the form of a lid, which is then weighted down with heavy stones or sandbags. The whole is left to settle for one night, after which the weights and boards are removed and the silo once again filled to the brim. The top layer of fodder, especially near the edges of the silo, is sprinkled with a fluid called "Mildew-death" which prevents the formation of mould. The silo is now ready to be covered in.

In covering, the object is to press down the material in the section above ground until its upper surface is level with the edge of the pit. Experience has shown that if the foregoing measurements and instructions are observed, this will be achieved by the pressure of a layer of clay 1½ feet deep. The procedure is as follows :—Over the green mass a layer of newspapers is first spread followed by a layer of wet sawdust or peat mould 4 inches thick. In autumn the latter may be replaced by beet leaves, in which case newspapers are not necessary. On the top of the sawdust (or beet leaves) is placed a layer of earth 20 inches deep, which is well trodden down and smoothed over. In the course of three days the green mass will have sunk down level with the top of the pit. The upper section, which is now empty except for the layer of earth, is removed—a matter of no

difficulty as it is constructed of six or eight separate pieces which are easily erected and dismantled. Its final form is that of a flattish cone so that rain water will easily run off. Finally it is covered with straw held down with planks or brushwood, which serves as a protection against extremes of weather. The pit remains in this state until its contents are needed.

Concrete towers may also be used. These are usually 25 feet high by 16½ feet in diameter and have a hole in the side through which the food is removed. The method of filling is the same as for the pits, but no newspapers, sawdust or earth need be employed as covering material. The top is covered with a wooden cover on which stones to the weight of 500 to 600 lb. per 10 square feet are placed, and the silo is roofed over when full. Concrete silos are usually built close to farm buildings, while the pits are generally dug in the fields at appropriate points, the food being carted in when required.

The food is ready after the lapse of about two months, and practically no loss of nutritive value is found to have taken place. Certain factors may, of course, cause failure. Water collecting at the bottom of the pit may injure the silage in varying degrees, in some cases entirely spoiling it. If the mass is not sufficiently tramped down, or if too little earth is spread on the top of the finished silo, air may penetrate, thus giving rise to the formation of moulds which cause protein breakdown and alteration of the pH index. Material which is not quite fresh at filling may also cause mould-formation. The correct addition of the A.I.V. liquid is another source of trouble, but with care and precision the preparation of the silage is reported to be easy and satisfactory. The silage should be removed from the pits in layers and not in blocks, and each time food is removed the pit should be recovered with sacking and straw as a protection against frost.

The A.I.V. Liquid and the Solution known as "Mildew-death."—The liquid supplied by the Valio Laboratory is diluted before use. One and three-quarter pints of liquid is added to five and a quarter pints of water. The quantity to be applied is varied according to the character of the green forage employed. It is stated that the quantities used for 200 lb. of green forage are the following :—

For clover and other leguminous crops ...	12 lb.
For grasses	10 ,,
For clover-grass mixtures	11 ,,
For kale and root-crop leaves	8 ,,

The quantities are for material of normal moisture content, but it is recommended that they be increased by 1 lb. per 200 lb. of green material if the weather is very dry when the crops are being carted. The composition of the acid solution to be added to the forage presents no scientific secret for, according to Virtanen, it is a matter of complete indifference what kind of acid innocuous to animals is used. It was only practical reasons which

led Virtanen to use an acid mixture in which the principal constituent is hydrochloric acid. To achieve success it is absolutely necessary to ensure that a definite quantity of this chemical solution comes in contact with a definite quantity of the forage to be preserved. Any alteration in the prescribed amounts will not give the desired result.

Close attention must be given to the prevention of the growth of moulds, which form one of the chief causes of failure. This is most liable to occur in the top layers of the ensiled mass where the access of air is easiest. In the search for a specific against mould, Virtanen proceeded from the observation that A.I.V. feeds prepared from cabbage tops do not as a rule become mouldy even when the silo pit was imperfectly covered and admitted a certain amount of air. From this he inferred that crucifers contain a substance toxic to mildew. This assumption proved to be correct inasmuch as the mustard oil found in the cruciferæ was very effective against mould even in high dilution. Using a solution containing 0·001 per cent. of allyl mustard oil no moulds occurred. This substance Virtanen has named " homesurma " or " mildew-death," and in a pit or elevator 16½ feet in diameter one-third of an ounce of " homesurma " is sufficient to protect the surface of the feed. Tests, undertaken to ascertain whether " homesurma " was harmful to animals, showed that high amounts fed to a cow daily for two weeks produced no ill effects.

Choice of Raw Material for Ensilage.—Attention has been given by the users of the process to the type of raw material which is most suited to this method of ensilage and what green crop is economically the most advisable to cultivate.

One must choose plants which have a luxuriant foliage and yield heavy crops, and the green material must be sufficiently juicy so as to facilitate pressure into compact masses. Leguminous crops, which naturally have a high nitrogen content, are the most important. Feeding peas and vetches are of this nature, but suffer from the disadvantage that they are weak in the stem, and hence are usually sown with some supporting crop such as oats or other cereal. These latter, however, are not entirely suitable for A.I.V. fodder owing to their encouraging the formation of mould during the process of conservation. In Great Britain and Central Europe the horse-bean (*Vicia Faba* L.) has been found to provide a satisfactory support to vetches and peas, and an excellent A.I.V. fodder which is readily eaten both by horses and cows is obtained therefrom. Pastures in which clover thrives come next in importance. Cuts should be made as early as possible, preferably just before the clover flower-bud is formed. Flowering Timothy grass is not recommended as a basis for A.I.V. feed. In Finland the cultivation of rye crops for silage appears to be gaining favour. Many other green crops have been used among which kale has been found very advantageous. The lower portions of the kale stem to a height of some 4 inches are quite valueless as food, however; therefore kale

should be harvested by a machine and not pulled up by the roots.

Characteristics, Composition, and Practical Feeding Tests.—A.I.V. fodder is readily consumed by animals. When ready it is rather moist and has a sweet and slightly acid taste. The odour is agreeable, and it is stated that cattle will take it in preference to turnips if offered a choice. Analyses of numerous samples of A.I.V. feed have been made, and it is claimed that food preserved in this way does not suffer any material loss of nutritive value. The accompanying table, compiled from Virtanen's own data, shows a comparison between the protein content of fresh Timothy grass and that of A.I.V. silage prepared from Timothy grass.

	Fresh Timothy grass. (Av. 6 samples.)	A.I.V. silage from :— Timothy grass. (Av. 12 samples.)	Clover aftermath. (Av. 3 samples.)
Per cent. dry matter ...	21 8	21 0	23·6
Per cent. crude protein in dry matter	14·8	14·6	17·2
True protein—			
Per cent. in crude protein	84·3	82·5	88·0
Per cent. in dry matter...	12 4	12·0	15·1
Soluble albumen—			
Per cent. in true protein	50 3	50·5	69·0
Per cent. in dry matter ..	6 2	6·0	10 4

According to these figures the true protein of fresh Timothy grass amounts to 84 per cent. of the crude protein. In the A.I.V. Timothy fodder the corresponding figure is 82·5, thus showing that little decomposition of protein substance takes place in the A.I.V. treatment. The proportion of soluble albumen in the true protein is the same for the fresh as for the ensiled grass, namely 50 per cent. In A.I.V. feed prepared from clover, the true protein averages 88 per cent. of the crude protein and the soluble albumen 69 per cent. of the true protein. Though corresponding figures for fresh clover are not quoted in the literature, these values are, according to Virtanen, the same as are found for fresh clover. It must be noted that from the published analytical data it is not clear whether the analysis of fresh Timothy grass was made on samples from the same crop as was ensiled and subsequently analysed after treatment, or whether the fresh grass figures refer to some different crop from that ensiled.

In feeding experiments it has been possible by using A.I.V. to the extent of 50 to 60 per cent. of the food required to reduce the usual amount of oil-cake by one half and still maintain an unchanged milk yield. Even more advantageous results can be obtained by using the feed at the rate of 70 to 90 per cent. of the total food, particularly if silage prepared from clover or clover-rich grass is used. In Table II the yield of four groups of cows at the same stage of lactation and on A.I.V. feeding is compared with four similar groups on ordinary feeding.

	A.I.V. Silage Groups.			Hay-Turnip Groups.		
	Food consumed.		Milk Yield Kg.	Food consumed.		Milk Yield Kg.
	Oatmeal Kg.	Oilcake Kg.		Oatmeal and Bran Kg.	Oilcake Kg.	
Group I (4 cows) ...	400·3	266·9	4,837·3	712·5	970·1	4,707·3
,, II (2 cows) ...	147·8	165·2	1,955·0	385·0	429·0	1,884·2
,, III (2 cows) ...	203·7	203·7	2,664·0	460·0	247·0	2,412·0
,, IV (2 cows) ...	232·6	232·5	2,860·2	362·6	362 6	2,496·1
Total ...	984·4	868·3	12,316·5	1920·1	2,008·7	11,499·6

In the A.I.V. fed groups there has thus been an increased milk yield of about 7 per cent. Furthermore, this has been achieved by the use of 56 per cent. less oil-cake and 48 per cent. less oatmeal (and bran) than in the normal groups.

In general, it appears that about 90 lb. A.I.V. fodder is considered the normal daily ration for milk cows of average yield. No digestive disturbances have been observed. A few examples of the results of feeding tests made on holdings where the live stock dietary was based on A.I.V. fodder are given below :—

(a) *Anola Estate.*—200 cows fed a daily ration of 90 lb. A.I.V. silage (Timothy and clover), 5 lb. concentrates (oatmeal and soya bean meal), 5½ lb. hay (inferior quality), and 9 lb. oat straw gave an average milk yield of 36 lb. per day.

(b) *Patiala Estate.*—25 cows fed a daily ration of 90 lb. A.I.V. silage, 5½ lb. hay, 13 lb. skim milk and 9 lb. oat straw gave an average milk yield of 36 lb. per day.

(c) An Ayrshire cow fed for 43 days before calving with 70 lb. A.I.V. silage, 3½ lb. straw and 6½ lb. hay gave after calving an average of 35 lb. milk per day for 51 days on an average ration of 6½ lb. hay and 84 lb. A.I.V. silage with no concentrates. The yield progressively increased from 32 lb. at the beginning to 44 lb. per day at the end of the period.

(d) A cow fed all the year round with about 5½ lb. hay and 90 lb. A.I.V. silage per day, together with pasturage for three months in the summer, and no concentrates whatever, gave a milk yield of 900 gallons during one lactation period.

Cost.—The cost per food unit of preparing A.I.V. silage is reported to be about equal to or rather less than the cost of hay making. In one case the cost of preparing 640 tons worked out at 3·1 man-hours and 3·5 horse-hours per ton of fodder. Calculated from Finnish currency at par rate of exchange the equivalent working cost in sterling is about one-fifth of a penny

per food unit. To this must be added the cost of growing the green crop and the cost of constructing the silo, which brings the total cost in the byre to about three farthings per food unit. The cost of building concrete towers and pit silos is relatively small, being for the former about £70, and for the latter about £5. These are the equivalent par sterling values of costs given in Finnish currency.

Costings made on one farm showed that, by using A.I.V. fodder, the cost of butter-fat production was reduced by 30 per cent.

Effects on Animals and Animal Products.—Fears have been entertained that A.I.V. fodder may react unfavourably on the metabolism of lime and phosphorus. Those qualified to speak, however, state that there are no grounds for this supposition, as after intensive tests of three years' duration no disturbance of mineral metabolism was noted. The ash of this fodder has a basic reaction, but one can further safeguard against acidity by adding a neutralizing salt. In fact, Virtanen recommends that chalk and sodium carbonate should always be given along with A.I.V. To 60 lb. of the feed, 2 ounces of chalk and 1 ounce of sodium carbonate is sufficient.

Large scale tests by the Valio concern show that the state of health of cows fed on A.I.V. feed was particularly good. In some few cases where the fodder used had been very much cooled down it caused chills and digestive disturbances.

The milk from cows fed on A.I.V. silage is said not to have the peculiar taste which occasionally results from the use of other types of pressed fodder, and many users of ordinary silage have changed over to the A.I.V. product for this reason. Butter has the rich yellow colour of summer butter, indicating that nothing is lost by this new method of preparing fodder. The consistency of the fat is the same in winter as in summer, whilst the crumbly texture, typical of winter butter, is eliminated. The only cheese that cannot be made from the milk of A.I.V.-fed cows is Emmenthaler, and researches are in progress to determine why this should be so. On the other hand, the milk is well adapted for the more acid cheeses such as Edamer, &c.

Use of the Method and Patents.—Thanks to the enterprise of the Valio Co-operative Dairy Concern, the method has been intensively developed in Finland and is apparently in widespread use in that country. The results obtained were so good that some 70,000 tons of A.I.V. ensilage were prepared in Finland in 1930. The measures adopted by Valio to promote interest in the process consist of lectures, advisory work, field demonstrations, &c., and in all 12,000 persons received instruction in the preparation of A.I.V. fodder during 1930. Instructional tours were extended to countries outside Finland, and the claims made for the process are being investigated in Denmark, Sweden and Germany. A certain amount of criticism of the process has been forthcoming from these countries of which mention must be made. One aspect of this has been to ascertain the import of Finnish claims to patent rights. The basic principle in the new

method of conservation has been protected in the most important cattle rearing countries by a patent applied for in the name of Virtanen and the Valio Co-operative Export Association. It appears that some objection has been made to the granting of patent rights on the grounds that the principle on which the method is based is not new. Virtanen admits that patent protection is not usually sought for discoveries relating to agricultural method, but takes the standpoint that possession of a patent gives impetus to the new enterprise. It stimulates the investment of money and facilitates the promotion of advisory propaganda. If, for example, anyone in Finland were free to sell acids for the preparation of A.I.V. fodder, no effective instructional work could be carried on in the face of competition, and the method would certainly fall into disrepute owing to faulty application.

In the latter part of 1931 considerable discussion took place in the columns of the Swedish agricultural press regarding the application of the Finnish A.I.V. method in Sweden. Controversy between Swedish agricultural authorities and Dr. Virtanen centred around the validity of the Finnish patent claims, it being pointed out that priority in the discovery of the use of hydrochloric acid for regulating the action of proteolytic enzymes belongs to Germany and not to Finland. Attempts to circumvent the patent were made by making slight alterations in the A.I.V. technique, and extensive investigations were carried out by Swedish agricultural authorities on a method described as "similar" in the main to the Finnish method. The essential difference in the Swedish method lay in the composition of the preservative solution, which consisted of molasses mixed with a small amount of hydrochloric acid and a little sulphuric acid. The amount of acid added is insufficient to stop fermentive processes, and the object of adding molasses is to hasten the formation of lactic acid, which otherwise takes place gradually at the expense of the plant carbohydrate stores. This procedure is different from the A.I.V. method, and it is thereby asserted that the patent claims of Virtanen are not transgressed. Virtanen eliminates enzyme action and makes an unfermented silage; the Swedish method regulates the biochemical changes and seeks to produce a fermented silage of good quality from the standpoint of dairy technique. Apparently, however, the controversy has ended satisfactorily as an agreement has been made between Dr. Virtanen and the Valio Co-operative Society in Finland on the one hand, and the National Association of Swedish Farmers on the other, whereby the A.I.V. patent rights have been acquired for Sweden. Presumably, therefore, the A.I.V. method will supersede the molasses method.

In Denmark, ensiling grass has not hitherto been widely practised, it being regarded as a risky method of preserving forage very often involving heavy loss in the destruction of valuable quantities of food. Consequently the claims made for Virtanen's method are being studied with much interest there.

In Denmark, too, priority claims are not lacking. Mr. N. T. Pederson, a Danish State agricultural expert, writes that he had made ensilage with hydrochloric acid some seven or eight years before Virtanen. The method was as follows :—To the fresh green material (kohlrabi leaves) 5 per cent. of a 2N or 3N solution of hydrochloric acid was added. Subsequently, an addition of molasses was made to ensure a rapid formation of lactic acid. The principle here is apparently similar to that involved in the Swedish method noted above.

A close study of the A.I.V. method has been made in Germany. To German science, according to Münzberg, the Finnish method offers but little that is new. In Germany, Fingerling has been working since 1925 on the question of conserving green food with the aid of acids and his applications for patents received early recognition. The Fingerling method is also characterised by conservation through the addition of hydrochloric acid in order to keep the hydrogen in concentration below pH 4. Early in 1926 Fingerling reported the results of his experiments to the German Agricultural Society and gave a preliminary account of a test made by Gorlach and Richardson, the outcome of which was that it would be premature to make known the details of the method before further investigation. Trials of the same nature by Wöhlbler are reported to have yielded very good results, showing that by the use of hydrochloric acid, beans, clover-grass, clover, vetches and other leguminous crops could be advantageously ensiled without any loss of nutritive value whatever, provided the pH index 4 was not exceeded.

At the annual meeting of the German Food Conservation Association held in Berlin in February 1932 mention was made of the impetus which had been given to the silo movement in Germany by the reports of the A.I.V. method reaching Germany from Finland. Methods analogous to the A.I.V. are being practised in many and widely separated districts in Germany and are reported to be giving brilliant results. Silage preserved with hydrochloric acid was readily taken by animals and agreed excellently with them, no trace of the added acid being found in the food.

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AVAILABLE PLANT FOOD IN SOILS.

NEW BIOCHEMICAL METHODS OF ESTIMATION.

A. M. SMITH, B.Sc., Ph.D., and R. COULL, B.Sc.,
Chemistry Department, Edinburgh and East of Scotland College of Agriculture.

Fertiliser Practice.—Although the use of artificial fertilisers in crop production has decreased slightly in the last year or two as a result of unfortunate difficulties in agriculture, the total consumption shows a remarkable increase over pre-war years. The present world consumption of nitrogen and phosphoric acid for agricultural purposes, for example, is approximately 1¾ and 3¾ million tons per annum respectively. At the same time, the fact that the total quantities of nitrogen, phosphoric acid and potash employed in lb. per acre of cultivated land are 5 for United States, 16 for Great Britain, 20 for France, 50 for Germany and 99 for Holland, suggests that the maximum figures have not yet been reached in many countries, and that when conditions have improved, even greater demands for fertilisers will be made. Even more significant is the fact that in large areas of the world, which still remain to be developed, the value of fertilisers is not yet fully appreciated.

That the fertiliser industry is alive to the possibilities of extension of the use of artificial fertilisers, and prepared to meet the varied demand, is quite evident from the rapid advances that have been made in the range and quality of the many products on the market. In addition to well-known and widely used substances like ammonium sulphate, superphosphate and the salts of potassium, there is now available a variety of concentrated compound fertilisers containing two or all three of the elements—nitrogen, phosphorus and potassium—which are commonly required to improve the yield and quality of the usual crops. The manufacture of those new products at prices which are quite commensurate with the prices of ordinary mixed fertilisers has been made possible through advances in the economic production of phosphoric acid from mineral phosphates and of ammonia from atmospheric nitrogen. Ammonium phosphates form the basis of these products and, by suitable means, may be combined with other salts to give a wide range of proportions of nitrogen, phosphoric acid and potash largely soluble in water. The experimental work which has been carried out with these compounds indicates that their effects are essentially the same as those of mixed fertilisers of similar composition, and they certainly merit increased attention on account of their very satisfactory physical properties. Their granular or crystalline form and freedom from stickiness, even under warm, humid conditions, make them very suitable for tropical countries, whilst their concentrated state (1 ton containing as much available plant food as about 2 tons of a mixed fertiliser) is of great importance where transport charges form an appreciable item in total cost of fertilisation.

These remarks are designed to show what has been done to place at the farmer's disposal the fertilisers that he wants. There still remains the question of sound advice to the farmer on his particular requirements.

Manurial Requirements.—The use of fertilisers has been based very largely upon trial and error demonstrations, the appearance of the crop under different treatments usually receiving greater attention than yield or quality. When one considers that even the most expert observer can seldom with confidence distinguish growing crops differing by less than 10 per cent. in yield, it is obvious that important differences may easily fail to be detected by visual examination alone. Innumerable yield trials are, of course, carried out, but, unfortunately, very often without due regard to the errors involved. Well-established and properly conducted field experiments are comparatively few in number, and the conclusions reached from them necessarily apply rigidly only to the particular conditions of soil, environment and so on in question. It is obviously impracticable to carry out an unlimited number of such experiments, and much attention has naturally been devoted to studying the manurial requirements of the soil under the less satisfactory laboratory conditions. The problem which has confronted the investigator is the question of the availability of nutrients required by the plant. It is well known that plants may respond to additions to a soil of certain elements necessary for growth, although the soil contains large amounts of those elements. Discrimination between available and non-available constituents is very difficult, partly on account of the heterogeneity of the soil and its ever-changing character and partly because the feeding power of plants is still a matter of controversy.

Availability of Plant Nutrients.—Many purely chemical methods have been proposed and adopted. Generally speaking, they involve an extraction of the soil with water or some dilute acid, and aim at estimating the quantities of those substances which would normally come into solution under field conditions as a result of chemical and biological changes and the effects of plant growth. In certain circumstances, when the results can be properly interpreted in the light of experience, the information obtained is of the greatest value for advisory purposes; but all chemical methods must suffer from serious defects. The results depend upon the technique, so that strict comparison under different conditions is difficult and frequently impossible; the results necessarily give only a measure of the state of the soil at a particular time, and obviously cannot apply to its conditions before, during and after cropping; no chemical method can imitate the lengthy and complicated process of assimilation of nutrients by the plant which undoubtedly plays an active part itself in helping to bring them into assimilable form. There is probably no hard and fast line between that part of a constituent which is available to the plant and that part which is not; the compounds of the soil are continually undergoing change, and

even the minerals and organic residues most resistant to decomposition are gradually broken down to supply plant food.

These fundamental difficulties have persuaded investigators to turn to the plant itself for information regarding the availability of nutrients and the manurial requirements of soils. This has given rise to an intensive study of the growth and composition of plants in various types of dish and pot experiments, with a view to determining what is easily available to plant and what constituents are lacking in the soil. Mention only need be made of the Mitscherlich and Neubauer methods of estimating manurial requirements. These methods are used widely and successfully on the Continent and have been described in detail in this *Journal* (1929, *12*, No. 3) by Stewart. Both methods are open to criticism because the soil is examined under artificial conditions and there are also certain objections on theoretical grounds; but there is no doubt that they are the best available methods for obtaining an estimate of the amount and composition of fertiliser required to improve the cropping power of the soil. The Neubauer method in particular is also commonly used as a test or control in the study of other methods of estimating soil fertility. One disadvantage of both methods is that they are not suitable for general use except by Institutes specially equipped and staffed for the purpose. The Mitscherlich method is costly and requires a whole growing season to obtain results, while the Neubauer method demands constant supervision and skilled analyses. Consequently, for the ordinary laboratory, which may be required to report on some hundreds of samples of soil annually, efforts have been directed towards finding a cheaper, simpler and more rapid method for routine purposes.

Biochemical Methods.—It has been observed that the development of certain lower organisms may form a good index of soil fertility; in other words, conditions which are satisfactory for the growth of higher plants are also usually suitable for some lower organisms. It is, therefore, possible to assess the cropping power of the soil by studying the development of a bacterium or fungus in the soil under suitable conditions, and, since the growth of these organisms is rapid, results are obtained in a few days. The possibilities of such a method have been known for many years, but its intensive study and practical application have been taken up only comparatively recently. For the estimation of manurial requirement the method is based essentially on the course of development of the micro-organism in a culture medium containing a definite amount of soil in place of the nutrient in question. Generally speaking, the higher plants and lower organisms react similarly to the different nutrients. Two types of organism have been employed for this purpose: (1) the bacterium *Azotobacter chroococcum*, and (2) the mould fungus *Aspergillus niger*, and it will be convenient to describe their uses separately.

The Azotobacter Method.—Azotobacter is an important soil micro-organism which is able to fix atmospheric nitrogen, and its

use in soil analysis originated in Denmark. It was observed, in the course of a series of liming experiments, that this organism developed when there was an adequate supply of bases in the soil but failed when the soil was acid. The sensitivity of the organism to acid conditions became the basis of a method of estimating the "lime-requirement" of the soil, but more accurate physico-chemical methods are now generally employed.

An adequate supply of phosphate is also necessary for the growth of Azotobacter, and the content of easily available phosphate in the soil may be estimated by studying the development of the organism under appropriate conditions. The organism must also have a sufficient supply of carbonaceous food and, for experimental purposes, that is ensured by the addition of some carbon-rich compound to the soil. Moisture and temperature are two factors which can readily be controlled in the laboratory, and the rate of development of the organism is estimated by the number and size of the colonies of cells which become visible to the naked eye after a short period of incubation.

The experimental technique for carrying out the test varies, but the following description will give an idea of one method of procedure. A known weight of fresh soil is mixed with a little starch, to provide a source of energy for the organism, and some kaolin, to increase the plasticity of the soil. The mixture is then divided into several portions, each of which is kneaded into a paste with water with or without the addition of such substances as calcium carbonate, a phosphate, a salt of potassium and so on. The various pastes are then placed in small dishes and left in an incubator at 30° C. for one or two days, when the colonies of the Azotobacter are observed. If the original soil contains sufficient nutrients, then there is no difference in the size and number of the colonies formed in the differently treated samples. If, on the other hand, there is a deficiency of some nutrient in the soil, then that dish which has received an addition of that constituent will show better developed colonies than any of the other dishes. In some cases it is necessary to inoculate the soil with a culture of Azotobacter.

Unfortunately, the development of the organism can be estimated only by visual observation. A system of estimation has, however, been adopted which is claimed to correspond closely to quantitative determinations of the nitrogen fixed by the organism. There is, of course, considerable experimental error but, in the examination of phosphate requirement for example, it is easy to grade the degrees of development into "poor," "moderate" and "good," corresponding respectively to large, moderate and small soil requirements of phosphate. There is practically no development of the organism in media containing no phosphorus, whereas with some soils there may be an extraordinarily large development indicating that phosphatic fertilisers would be superfluous for the next crop. There are, therefore, wide limits within which estimates may fall. Many investigators have compared the results with those obtained by

other methods of estimating manurial requirement. Professor Niklas and his collaborators at Weihenstephen in Bavaria, for example, have examined some 2,000 soils by the Azotobacter and Neubauer methods and found good agreement in 75 per cent. of the cases and poor agreement in only 10 per cent. What is perhaps more important is the fact that the agreement was best for that group of soils showing a low content of available phosphoric acid by the Neubauer method. As already indicated, the Neubauer method is not beyond criticism, but it gives results which may with some confidence be regarded as giving a measure of the readily available plant nutrients in the soil. There seems to be reason to expect, therefore, that the Azotobacter method should prove of considerable value as a rapid and cheap routine method for testing the fertility of soil samples.

The Aspergillus Method.—This method has been developed more recently but is similar in principle to the Azotobacter method. The necessary conditions of growth of the two organisms are quite different, however, for whilst Azotobacter requires an approximately neutral medium, *Aspergillus niger* develops well in acid media, and whereas the degree of development of Azotobacter cannot be measured accurately, it is possible to collect the fungus and weigh it. It has no claim to be an accurate quantitative method, but rather a means of linking up the more qualitative Azotobacter method with the Neubauer and various chemical methods, its great advantage over the latter being simplicity and speed for routine analyses.

The name "*Aspergillus niger*" is applied to a group of those fungi commonly known as moulds. The genus Aspergillus is characterised by the interlacing of tubular filaments to form a vegetative felt, called a mycelium, which is coherent and easily handled. Reproduction takes place in various ways but, in that which chiefly concerns us, large numbers of conidia or spores are produced. The conidia, each of which is capable of developing into a new plant, are almost black in colour and are responsible for the dark velvety appearance which is typical of the fungus.

In comparative work, it is essential that a standardised technique be followed because the weight of mycelium found depends upon the amount and relative proportions of food material available. If the concentration of the solution be too great, the growth proceeds for an inconveniently long time, whereas if the concentration be too low, the weight of mycelium formed is too small since it is closely related to that nutrient which is the limiting factor. The culture solution, containing all the constituents necessary for growth except that for which the soil is being tested, also contains 1 per cent. citric acid. This ensures a strongly acid reaction which is favourable for the growth of the Aspergillus and reduces the disturbing influence of other organisms.

There is, therefore, a certain similarity to chemical methods which make use of citric acid to bring easily available nutrients

into solution; one difference, however, is that in the biochemical method one nutrient is being examined in presence of excess of all the others, whereas in the purely chemical methods the proportions of the nutrients present in the soil remain unaltered. As a matter of fact, the growth of Aspergillus is not so great when a citric acid extract of the soil is used in place of the soil itself and the results do not agree so well with those from the Neubauer method. That is to say, more nutrient is withdrawn from the soil during the growth of the organism than by the extraction with citric acid. This might be expected since the acid extraction gives us the amount of nutrient which is dissolved at room temperature under definite experimental conditions. The value obtained in the Aspergillus method, on the other hand, corresponds to the supply of nutrient which becomes available during the vegetation period when the temperature is higher, the acidity becomes greater and the plant nutrients are undergoing constant change.

The results are also affected by the particular strain of the organism used and by the temperature of incubation, which must be carefully controlled. Unless all these factors are maintained nearly constant, it is quite possible for different soils containing the same amounts of potassium or phosphorus to give quite different results. As it is, much more constant results are obtained when potassium is the limiting factor than when available phosphate is under investigation. That is quite in keeping with the fact that the subject of soil phosphates presents one of the most involved questions in agricultural chemistry. The variations which occasionally occur are undoubtedly a weakness in the method, because uniformity of results is essential for any satisfactory method of investigation. No method, however, depending upon living organisms which do not obey strict chemical laws can be expected to provide perfectly constant results; the success of the Aspergillus method must, therefore, be circumscribed by certain reservations. Studies in the behaviour of the organism are being made at various places, and the interpretation of the results will become more certain when all the variable factors have been thoroughly investigated and adequate comparison made with other data.

Technique.—The procedure generally adopted is as follows. A culture solution must be used in which the satisfactory development of the organism is not affected by the addition of soil except by the particular nutrient under investigation. A suitable solution contains 10 per cent. cane sugar, 1 per cent. citric acid, 0·6 per cent. ammonium sulphate, 0·1 per cent. peptone, 0·03 per cent. magnesium sulphate, 0·00015 per cent. copper sulphate, and 0·0001 per cent. each of zinc and iron sulphate. For the estimation of available potassium of the soil the solution also contains 0·075 per cent. phosphoric acid (as primary ammonium phosphate), and for the estimation of available phosphate the solution contains 0·02 per cent. potash (as potassium sulphate). The soil to be examined is dried in air and passed through a

2 mm. sieve, as is usually done in soil analysis. For potassium estimations 25 or 30 cc. solution are added to 2·5 g. soil in a small flask; for phosphate estimations 30 cc. solution are added to 5 g. soil. If the soil is rich in organic matter, it is wrapped up in filter paper to prevent floating material from becoming mixed up with the fungus. If the soil contains more than about 1 per cent. free calcium carbonate, it is necessary to add sufficient citric acid to neutralise the carbonate and to set aside the flask for one or two days before inoculation. The mixture is then inoculated with the organism. A suspension of conidia is prepared from a culture of a suitable definite strain of *Aspergillus niger*, and a few drops are added to the flask. The mixture is then incubated for from four to six days according to the object of the experiment. During that time the mycelium develops and covers the surface of the liquid like a felt. When the growth is large, the surface presents a corrugated appearance and is tough and almost rubber-like to touch. The mycelium is removed from the flask, washed with water to free it from any adhering soil particles, dried slowly in an oven and weighed. In order to reduce experimental error, it is customary to carry out the estimations in triplicate or quadruplicate. A large number of experiments have shown that the standard error of a single determination is of the order 4 per cent.

During growth, the acidity of the suspension increases to a certain extent, due mainly to utilisation by the fungus of the nitrogen of the ammonium sulphate with liberation of free sulphuric acid. The change depends upon the rate of development of the organism and the chemical nature of the soil. It is not possible to control the acidity during growth so that, since the amount of nutrient which becomes available is related to the degree of acidity of the solution, it is obvious that the more active the growth of the organism the better will become the conditions for setting free the limiting nutrient. Consequently, the differences between soils will tend to be exaggerated since the final degree of acidity may lie between fairly wide limits. This is particularly important in cases of phosphate estimation, and probably accounts in some measure for the greater lack of uniformity compared with the potassium estimations. If, under certain conditions, the growth is allowed to proceed too long, then the protein compounds of the mycelium break down with liberation of ammonia; this reduces the acidity of the medium to a point favourable for other micro-organisms and the Aspergillus may be decomposed to such an extent that it cannot be collected. The addition of citric acid to the culture solution and the time of growth are, therefore, two factors of the utmost importance in the method.

Results.—The many published results of the Weihenstephen experiments are of great interest and, for convenience, have been summarised in the accompanying Table I.

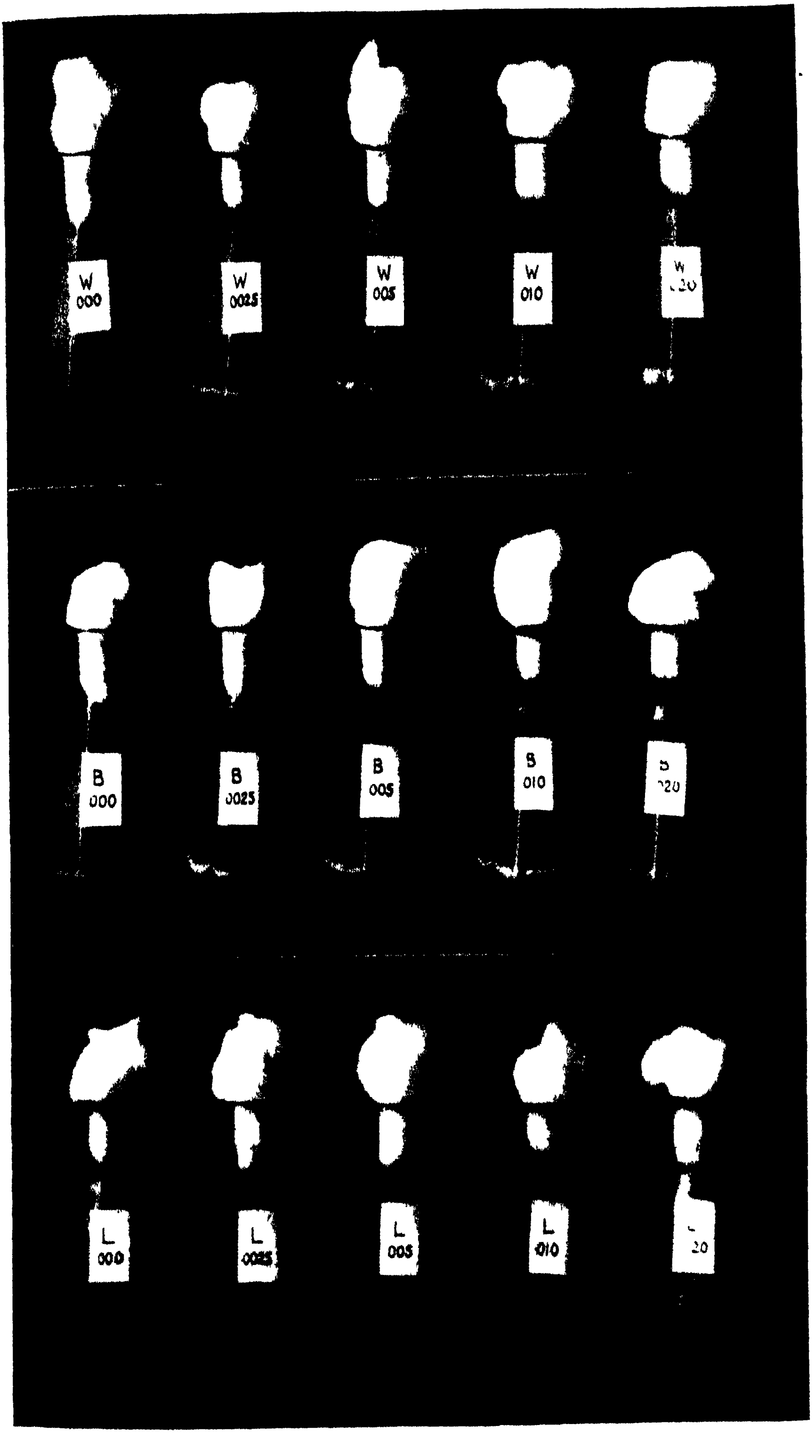

FIG. 1.

Aspergillus niger. Increasing percentages of P_2O_5 added to soils W, B, L. Sixth day incubation.

TABLE I.

Comparison of Results obtained by Aspergillus and Neubauer Methods.

Weight of mycelium in gram.	Plant food supply of soil according to Neubauer test.					
	Phosphoric acid (P_2O_5).			Potash (K_2O).		
	Too small.	Moderate.	Very good.	Too small.	Moderate.	Very good.
0–0·3	96	5	0	35	2	0
0·3–0·6 ...	36	34	7	39	52	3
Over 0·6 ...	1	28	30	0	12	32
Total soils examined	133	67	37	74	66	35

The results obtained from the examination by the two methods, of 237 soils for phosphate requirement and 175 soils for potash requirement, are grouped according to the weight of mycelium formed under standard conditions of experiment, and the supply of nutrient in the soil according to what has been removed by seedlings. For example, of the 133 soils which, by Neubauer's seedling method, contained inadequate amounts of easily available phosphate 96 gave only from 0 to 0·3 g. of dry mycelium from the growth of Aspergillus; in only one case did the weight of mycelium exceed 0·6 g. Of 35 soils in which there was a very good supply of available potash by the seedling method, 32 gave over 0·6 g. mycelium and the other three from 0·3 to 0·6 g. It will therefore be observed that, generally speaking, the richer the soil according to the seedling method, the greater the development of Aspergillus. The limits have been arbitrarily selected, but, as far as phosphate is concerned, the agreement between the two methods is very good for the poor and rich soils but only moderately good for the intermediate soils. This is partly due to the fact that the fungus requires a good supply of phosphate for growth and gives a marked response to additions of phosphate only within comparatively narrow limits. A normal dressing of phosphatic fertiliser on poor or rich soils, therefore, will not give a very definite response. Furthermore, the absorption of phosphoric acid by the organism is not constant from different types of phosphate.

An idea of the results which have been obtained in the examination of East of Scotland soils for phosphate deficiency will be gathered from Fig. I. The three soils differ markedly in physical and chemical properties. Soil W is an uncultivated sandy loam and B is an average heavy loam, both from the College farm, Boghall; L is a rich garden soil from the College Gardens. It will be observed that the growth of Aspergillus varies considerably on the untreated soils and that the successive additions of soluble phosphate have had diverse effects. The addition of 0·005 per cent. P_2O_5 to the soil is roughly equivalent to a dressing of 7 or 8 cwt. of superphosphate per acre.

The average weights in gram of mycelium obtained in the above experiment were as follows :—

Percentage of P_2O_5 added to soil.	0·000	0·0025	0·005	0·010	0·020
W Sandy loam	0·29	0·42	0·50	0·53	0·63
B Heavy loam	0·42	0·44	0·46	0·50	0·59
L Garden soil	1·16	1·20	1·21	1·20	1·19

These figures are quite typical of the range of results for soils in this area.

A large number of results are also available for a variety of Bavarian soil types on which field and pot manurial experiments had been carried through. The samples which had received no fertiliser or complete fertiliser without phosphate invariably gave the lowest results. On the other hand, the highest figures were almost always obtained with the samples which had received complete fertiliser less nitrogen, indicating that the previous crops had been unable to utilise the phosphoric acid on account of the lack of nitrogen. The use of farmyard manure, with or without the addition of artificial fertilisers, was also responsible for a marked increase in the growth of Aspergillus. Although the method has, therefore, certain characteristic sources of error, it does fall into line with field practice.

With regard to the results for potash estimation, the agreement between the two methods (Table I) is very good except for the poorer soils. The discrepancy may be explained on the assumption that the fungus can make better use of small quantities of not readily available potassium than the seedlings; but detailed results of further investigation have still to be published.

Excellent agreement has been obtained with soils from various field and pot fertiliser experiments. The lowest results were generally obtained from those samples which had received no fertiliser or complete fertiliser less potash, and, as in the case of phosphate estimations, the application of farmyard manure exerted a considerable influence on the development of the fungus. The Aspergillus method for the estimation of potassium requirement of soil is, therefore, likely to be of great value in assessing the behaviour of soils in the field. It cannot give a quantitative measure of the actual quantity of easily soluble potassium, but it can give a reliable indication as to whether the soil is poor or rich in available potassium.

Acknowledgments.—In our examination of the method we have been greatly indebted to Dr. Cunningham and Mr. Gibson of the College for assistance and facilities; to Dr. Wilson, Edinburgh University, and Dr. Poschenrieder, Weihenstephan, for strains of *Aspergillus niger;* and to Mr. Wannop and Mr. Leask of the County Staff for soil samples.

Literature.—An extensive bibliography of investigations in the field of microbiological and biochemical methods of soil analysis will be found in the following papers :—

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THE BIOLOGIST on the FARM.—No. XLVI.

Sir J. Arthur Thomson, M.A., LL.D. (Edin.; McGill; Calif.; *et* Aberd.),

Emeritus Professor of Natural History in the University of Aberdeen.

The Cat and the Mongoose.—Everyone has read or heard some account—usually spotted with inaccuracies—of the way in which the mongoose, transported from the Old World to Jamaica in order to check the plague of rats, went far beyond its remit and killed off a number of creatures which were better left alone. The problem arose : How to eliminate the eliminators? " Too much of a good thing " may apply to the mongoose, that is certain. And also to the musk-rat. But this was not the story we meant to tell; no, nor the other one either.

In a recent letter to *The Times*, the Very Reverend Sir David Hunter Blair tells us (including the inhabitants of Tristan da Cunha) that a mongoose will soon earn its keep. One of these engaging carnivores was recently introduced to the Abbey of Fort Augustus in the hope that it would check the alarming increase of rats coming up from Loch Ness. This it has succeeded in doing in a surprisingly (perhaps suspiciously) short time; and the relief experienced in the Abbey might be echoed in many other places, provided only that the mongoose is kept strictly in the singular, which is also the most convenient number conversationally.

But it is the frame of the picture that we most admire. The Abbey cat was at first rather perturbed by the introduction of the strange alien " with its long body, its short legs, and its wicked-looking head." But it was wise among the wise, and it

is almost like a picture from a Hebrew prophet to read that "puss and the ichneumon have made friends, and play amicably together in the refectory, while the monks are at their meals." When the rats are away the cat and the mongoose play; and it is not such a bad world after all!

A Feather-Poke Nest.—About the middle of April this year we had an enjoyable opportunity of studying the nest of the Long-tailed Tit. It was fastened to the slender branches of a spruce tree and mostly camouflaged with grey lichen. The rest of the outside of the nest was composed of green moss intertwined with a little wool and the like. The "door," which is usually near the top on one side, seemed to be closed, perhaps by the long tail, about three inches long to a body of two. The nest was about 5½ inches in length, so that there was not much free play, especially since the interior is almost filled with hundreds of small feathers, neatly woven into a quilt, admirably suited for the disamenities of British spring weather. We have heard that its only imperfection is the lack of any arrangements for draining off too frequent showers. The nest may become water-logged and the crowded young ones may drown or die of cold. As is the way with wrens, the Long-tailed Tits sometimes use the "feather-poke" nest as a winter shelter, and it is certainly inviting. As many as 2,379 feathers have been counted in the nest of the Long-tailed Tit, and these have to be gathered and "handled" individually by the parents, who require about a fortnight for their delicate work. As the nest has survival value in securing the welfare of the young, and as the maker of the quilt is a very successful bird, extending from Britain to Japan and very hardy, joyous, and adventurous everywhere, in spite of its seeming frailty, we see the inaccuracy of the idea that Darwin's struggle for existence always involves internecine competition. The quilt of the titmouse—a skilled response to cold weather as well as to the hungry eyes of enemies—pays as surely in Nature's sifting as the equipment of the hawk with beak and talons. The struggle for existence is often an artistic endeavour after wellbeing.

We do not know which to admire most, the inside or the outside of the nest, both made of material which has to be collected from elsewhere. But on the whole the piecing together of the outside lichen seems to us the most remarkable feature of this "home without hands." Miss E. L. Turner speaks of the fine picture when the bird clings to the outside of the cradle or nursery. "The soft blending of black and white in its plumage, together with the flush of pink on breast and flanks, make a beautiful colour scheme which somehow melts into the silver-and black lichen composing the exterior of the nest. The tail is then used as a support, being curved elegantly upwards, giving an idea of hitherto unsuspected strength latent in this long slender appendage."

The bird seems to be instinctively or innately endowed so that it must make this type of nest, but it is difficult to refuse to credit

it with some measure of selective appreciation. There is a spice of individuality in the achievement, and the bird looks as if it enjoyed its artifice. In the strict sense, we suppose, art is the deliberate expression of an idea or an emotion in some significant medium, and " instinctive art " is almost a contradiction in terms. Yet we must not be too sternly logical with life, or ignore the element of purposiveness behind the bird's behaviour. The nest-making is long-drawn-out but it does not wander from the point; it is patient and yet joyous; it is to some unknown extent suffused by an awareness that what is being fashioned is a cradle. Thus perhaps it draws near the confines of art.

A genial friend to whom I showed my treasure said, " You seem to be mighty interested in that little nest." And that is just what I was and am. For it is an item in the wonderful world in which we have the privilege to live,—an item that excites our sense of beauty, our sense of wonder, and " thoughts about things that thoughts do but tenderly touch." It is the kind of thing that the Biologist on the Farm cannot leave out of his philosophy.

And if you are so hard of heart that you regard all such talk as irrelevance, then, we suppose, we must remind you that the very industrious fashioners of the feather-poke nests feed their young ones from dawn to dusk with caterpillars small and large, whose reduced numbers mean increased prosperity to the farmer. So it was not an irrelevance after all!

OAT BREEDING.

Notes on Two New Varieties of Oats recently registered by the Department of Agriculture for Scotland.

WILLIAM ROBB, N.D.A., F.R.S.E.,
Scottish Plant Breeding Station.

THE climatic conditions in many districts of Scotland during the summer and autumn of some recent years have served to emphasise certain deficiencies of many oat varieties. On fertile soils excess of moisture during the growing period tends to promote the development of soft straw, and, if towards harvest time much rain occurs, many heavy crops of oats become so badly laid and twisted that much extra expense is often entailed in satisfactorily harvesting them. Further, when a crop of oats follows pasture in which there has been wild white clover the crop is frequently heavy, and in consequence there is a greater chance for lodging to occur. The securing of badly lodged crops being expensive, enquiries are frequently made by farmers for a productive oat variety that will not readily lodge. In addition, there is a demand for varieties of oats specially adapted to the poorer soils and suitable for the later districts in Scotland.

When the Scottish Plant Breeding Station was instituted at Corstorphine in 1921 it was decided, in view of the importance of the oat crop in Scotland, that a strong and sustained effort should be made to produce some improved varieties of oats in which characters such as upstanding straw and early-maturity should be combined with adaptability and productiveness. The purpose of this paper is to give a brief account of the work on the breeding of oats at the Scottish Plant Breeding Station, and to indicate what has so far been accomplished.

Variability exists in different degrees in many oat varieties, but if those variations which are due simply to admixture are excluded, the amount of variation is not nearly so great as it frequently is in other crop plants such as swedes and grasses. One reason for this greater degree of uniformity in oat varieties is that the oat plant is almost always self-fertilised in nature, and another is that many of the cultivated varieties have attained a high degree of purity through careful and persistent selection. Intercrossing of oat plants doubtless does occur and possibly, under favourable conditions, a little more frequently in some varieties than in others, but there is reason to believe that such occurrences are comparatively rare. In the opinion of the writer it seems probable that when oat plants occur in a crop and show a new combination of old characters, or show new characters, they may have arisen from a natural cross, or from the more rare but sometimes valuable forms which emerge following a fundamental change in the hereditary material of a plant. Since natural crosses seldom occur in oats the practice of the time-honoured method of single plant selection alone is not regarded as presenting much scope for obtaining new types. Greater scope is obtained by crossing oat plants deliberately and by growing and comparing the hybrid plants in a systematic manner.

The technique of cross-pollinating oat plants is not particularly difficult, but, in this area at any rate, the climatic conditions prevailing at the time of pollination influence the setting of seed. In the writer's experience, when artificial pollinations are made during dull, damp weather very few crossed grains result, but when the atmospheric conditions are dry and warm a much greater proportion of the hand-pollinated florets set seed. Over a period of several years the number of crossed grains secured has averaged about 25 per cent. of the number of florets which were emasculated and hand-pollinated. It would seem that, as in the case of barley, oat pollen, once it is liberated from the anthers, retains its viability for only a very short time. Further, the stigmas, which form part of the female organs of the floret and which play an important part preceding fertilisation, seem to remain receptive only for a short time. Therefore, unless the pollen used is viable and the stigmas to which it is applied are in the appropriate condition to promote active germination of the pollen grains, seed will not set. In order to preclude the possibility of self-fertilisation taking place, the anthers must be removed before they reach maturity. This is a

delicate operation and care must be exercised so that the floret is not damaged in any way.

In crossing plants artificially the ultimate object is to produce a plant in which certain of the characters or capacities existing separately in the two parents are combined. A wide range of variability is frequently found in a family of hybrid plants, but the greater the amount of variability among the hybrids, the greater generally are the chances of obtaining new and improved types. A general indication may be obtained of the nature of the variations that occur if we assume that two varieties of oats have been successfully crossed. Let us say for example, that one of these has *black grain and open, spreading ears or panicles*, and that the other has *white grain and close one-sided ears*. The first generation plant arising from this crossed grain will possess black grain and the ear will be more or less of the open, spreading type. When the grain from this plant is sown we reckon to obtain, in addition to plants similar to the parent types, some plants which possess *black grain and one sided ears* and some which possess *white grain and open, spreading ears*. Results of this kind show that a combination is possible of certain characters of one plant with those of the other. Generally speaking, this re-arrangement of the factors controlling the characters involved takes place at random during the process of fertilisation. The greater the number of contrasting characters in the parent plants—e.g. black and white grain; large and small grain; open and close ears, &c.—the greater will be the range of variability among the offspring. Since in oat crosses, as in many other crosses, the full possible number of variants is more likely to appear in a sufficiently large second generation than in any other, it will be obvious that it is most important to grow a large number of second-generation hybrid plants in order to permit all or as many as possible of the variants to appear. Even if only two pairs of contrasting or Mendelian characters such as colour of grain (black and white) and type of ear (spreading and one-sided) are involved, in sixteen second-generation plants there is but a small chance for all the possible combinations of these characters to appear. If the contrasting characters are increased to four pairs, then in 256 second-generation plants there is again only a small chance that all the possible types will occur. In practice, therefore, it is desirable to grow a much larger amount of plants than the theoretical number in order to ensure that all the variant types may be produced, for certain types in comparison with others have a greater chance of occurring.

While intercrossing presents many possibilities of obtaining new combinations, such new types if they are mere novelties are not all that is required. A new type must show some improvement, from a practical point of view, on the already existing varieties that are grown. In the hybrid progenies some of the new types are almost certain to be inferior to or no better than the parent varieties, and the breeder has to

select by eye in the first instance those plants which show in the highest degree the characters he desires.

In commencing breeding work to explore the possibilities of producing improved varieties of oats by hybridisation, it was decided to use some of the old established Scottish varieties and to cross these with other chosen varieties. The old varieties like Potato possess certain desirable characters, such as hardiness, adaptability, good quality of grain and straw, and these are desirable attributes of new varieties. The well-known oats Potato, Sandy and Tam Finlay were therefore used as parents, the Potato variety being used to a greater extent than the other two.

In these breeding experiments, after a hybrid grain has been obtained and propagated and its progeny has reached the second generation, it has been the practice at this stage to select single plants which show most promise in the desired direction. Seed is taken from each selected plant for sowing separately and this process is repeated for several generations, seldom less than six, because few, if any, of the hybrid plants before that time will be producing plants similar in all important respects to their parents. It will be obvious that it is not desirable to have in practice an admixture of different grain-colour types, or of types varying for any other character of practical importance. Once the condition of breeding "true-to-type" is reached the next part of the procedure is to compare the hybrid selections among themselves and to compare them also with standard varieties. Since the amount of grain from the fixed hybrid selections is always small in the earliest stages, the preliminary trials have to be conducted on a small scale. These small-scale trials, however, enable fairly accurate preliminary comparisons to be made, and they permit of the less desirable hybrids being confidently eliminated. The most outstanding selections are then propagated on a larger scale, and they are subsequently subjected to more extensive trials, not only at the Plant Breeding Station, but also in field trials in different parts of the country, including those of the Plant Registration Station for Scotland. The trials in different counties are frequently arranged in co-operation with the Agricultural Colleges, and they are generally supervised by the Agricultural Organiser for the County in which they are conducted.

In general, about 10 to 12 years are required for the breeding and testing of a new oat raised from a cross. Oat-breeding has been in progress at the Scottish Plant Breeding Station, Corstorphine, since 1921, and recently two hybrid varieties produced at the Station have been put into commerce. In view of the practical outcome of this work the time is perhaps opportune to give an outline of the history and the chief characteristics of the two hybrids.

One of these two varieties was obtained from a cross between the well-known varieties Castleton Potato and Beseler's Prolific. The crossed grain was obtained in 1919 and it was sown in 1920.

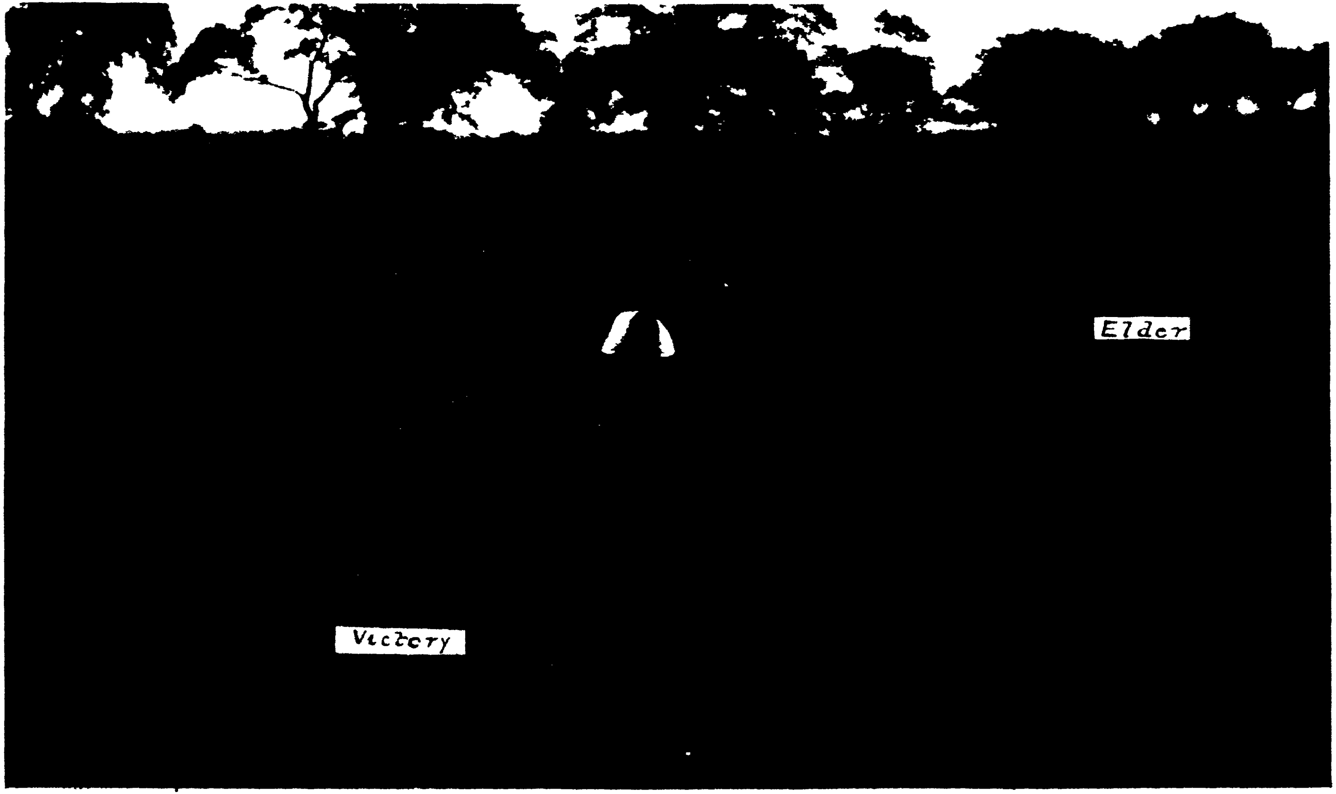

FIG. 1.—PLOTS OF ELDER AND VICTORY OATS, 1929

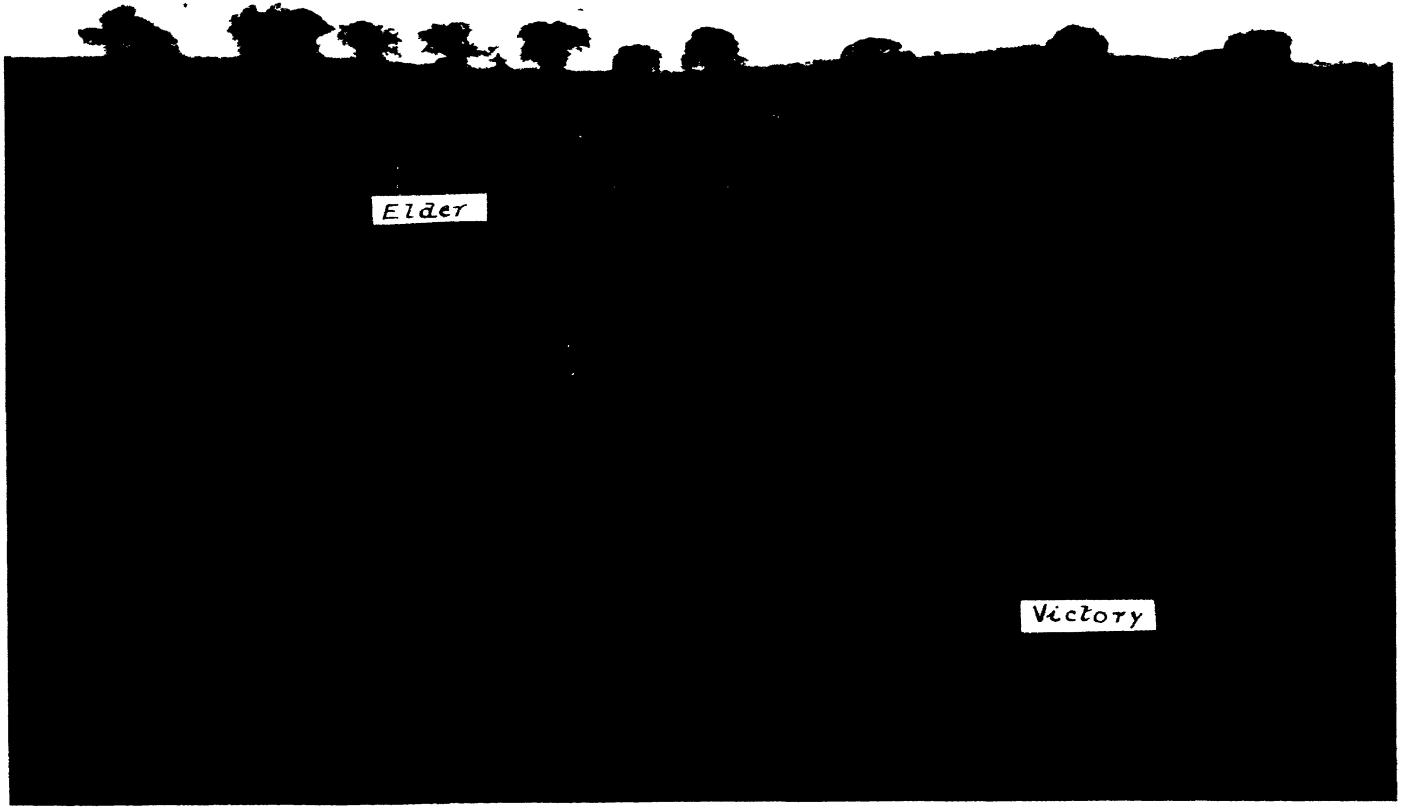

FIG. II.—PLOTS OF ELDER AND VICTORY OATS, 1930.

All the resulting produce of the hybrid plant, amounting to about 500 grains, was sown in 1921, and a second generation amounting to over 300 plants was obtained. It was obvious while these plants were growing that they were of hybrid origin; some plants bore a greater or less number of the Potato characters while others bore a greater or less number of Beseler's Prolific characters, thus showing that certain of the Potato characters had been combined with some of those of Beseler's Prolific. In addition to the hybrid plants bearing only characters shown by one or other of the parents, there appeared in the third generation a few plants that bore at least one character not exhibited by either parent. These few plants possessed relatively short straw, about 6 inches shorter than the average type, and well-furnished "heads" or panicles bearing medium-sized, well-filled grain. These plants were quite distinct and looked promising, particularly as the type of straw and the system of root development indicated that they should be resistant to lodging. These short-strawed plants were therefore included amongst the other third-generation plants from which seed was taken for propagation in 1923. The seed from each plant was, of course, kept separate. This process of selecting and sowing grain from the selected single plants was continued for a few years until in 1926 several types, including those possessing short straw, appeared to be breeding true for the essential characters. Once true-breeding strains were obtained, the grain from each of these was still kept apart and sown separately, but the resulting produce of each strain was then bulked. This first bulking marks the initial stage in the multiplication of a new variety, and provides material for the first small trial-plots. The results of preliminary trials showed that the short-strawed types were decidedly more resistant to lodging than the longer strawed ones. In due course one of the most promising of the short-strawed hybrid selections was included in the official Registration Trials conducted at the Plant Registration Station, East Craigs, Corstorphine, by the Department of Agriculture for Scotland. These trials extended over a period of three years, and comparisons of the hybrid selection were made throughout that period with standard varieties. The weather conditions in 1929 and 1930 were very helpful for comparing the standing powers of oat varieties, and it was evident that the new selection possessed a type of straw that did not readily lodge. This selection was recognised as a new and distinct hybrid variety, and in November 1930, as a result of the trials it had undergone, it was registered as a new variety under the Department's Scheme for the Registration of Cereals. The Certificate of Registration states that the special qualities of this new variety, now known as "Elder," are:—

(1) Its good tillering habit.
(2) Its special capacity to withstand lodging.
(3) Its well-furnished head of corn.

(4) Its good yield on fertile soils.
(5) Its attractive sample of grain.
(6) Its suitability as a lea oat.

In field trials in 1930 and 1931 at Boghall Experimental Farm, Midlothian, Elder was placed first in order of standing capacity. At Craibstone Experimental Farm, Aberdeen, in 1930 in Standing Power Trials, Elder withstood lodging better than any of the other eight varieties in the trials. In field trials yields of 30 cwt. of grain per acre have been obtained, and in one instance a yield of about 40 cwt. was reported from a trial in East Lothian.

The illustrations (Figs. I and II) show plots of Elder and Victory oats alongside of each other at the Plant Registration Station, Corstorphine, in 1929 and 1930. The photographs were taken a short time before the crops were cut. In Fig. I the Victory oats are seen in the foreground—badly lodged—while Elder, which is seen immediately behind, is standing quite erect and was cut without difficulty by the binder. In Fig. II the Victory oats are lodged and much twisted, whereas Elder was practically unaffected by the heavy rains and was cut by the binder without hindrance.

At the Plant Breeding Station, Elder has frequently matured about the same time as the Swedish variety Victory, but in 1931—a late season—Victory matured a few days earlier. It would appear from various trials that the Elder oat is best adapted to fertile conditions in the earlier districts of Scotland. Attention may also be drawn to the fact that it is a variety which should not be allowed to become dead ripe before cutting since, if windy weather occurs at harvest time, some of the grain may be shed.

The second of the hybrid varieties already referred to as having been put into commerce recently was raised from a cross between Sandy and Leader, secured in 1915. The second generation hybrid grains were not grown for a few years during the war, but they were sown in 1919, and in the succeeding years progeny plants were grown and selections made in the manner already described. Several widely different types appeared amongst which were some early-ripening plants. These were included in the original selections and they produced some promising types. Eventually from these, two early-ripening selections with medium-sized, slightly pink grain, which were breeding true-to-type, were retained for comparison on a larger scale. The object in selecting these plants was to obtain an improved type of the Sandy oat, a variety which is still grown in districts in the West and North of Scotland. These two fixed hybrid selections were tested in different districts in Scotland, and as one of them appeared to give a rather better yield of grain than the other it was subjected to further trials at the Plant Registration Station, Corstorphine, and also in other field trials. Favourable reports of this variety were received from trials in Orkney,

Caithness and Dumfriesshire. After several years' trials, the Department of Agriculture for Scotland, in view of the suitability of this oat for growing especially on poor soils and in late districts, registered this variety in January 1932 in terms of their Scheme for the Registration of Cereals. The following is the official description of this hybrid oat, which is now known as " Bell " :—

> " An early variety having many of the characters of Sandy Oat; of good tillering habit; very early in ear, maturing slowly; earlier in ripening than Sandy or Potato oat; having a moderately good yield of medium grain, faintly pink tinged; not liable to shed; having a large yield of good straw not so liable to lodge as Sandy; suitable for poorer soils and late districts."

This new variety " Bell " has generally ripened at Corstorphine about ten days earlier than Elder; its straw is longer than that of Elder and rather more liable to lodge. Bell was selected as a possible substitute for the small-grained Sandy Oat, and from reports received there is reason to believe that it will compare favourably with the older and smaller-grained variety.

Many other hybrid selections of oats are undergoing preliminary trial at the Plant Breeding Station, Corstorphine, and, as with those referred to above, all new varieties, before being put into commerce, are being submitted to the Department of Agriculture for Scotland for inclusion in their official trials. In addition to these, trials are also carried out in different districts throughout Scotland with a view to ensuring that the probable degree of utility of each new variety raised by the Society is ascertained as fully as possible before any claims are made regarding it.

The search for improved varieties of oats by crossing selected plants of different varieties has been encouraging, and there is reason to believe that further improvements will be obtained by a combination of the operations of discriminate crossing and single-plant selection and by continuing to work along systematic lines.

Note.—Mention may be made here that the members of the Scottish Society for Research in Plant Breeding were the first to have opportunities of obtaining seed of the Elder Oat in 1931 and 1932. Seed has been disposed of only through members of the Society, and it is estimated that well over 100 acres of the Elder Oat will be grown in 1932.

All the available seed in 1932 of the Bell Oat—the produce of about 4 acres in 1931—was disposed of to members of the Society who had applied for seed in response to the Society's invitation.

THE ESTABLISHMENT OF PASTURE ON VIRGIN PEAT.

D. CLOUSTON, M.A., B.Sc.,

Lecturer in Agricultural Botany, North of Scotland College of Agriculture.

THE trials described in this paper were conducted by the Macaulay Soil Research Institute on the Demonstration Farm in Lewis, and their inception is described in a previous issue of this Journal.[1]

Natural Vegetation.—The natural vegetation on the peat is that referred to botanically as Scirpus association—a type poor in species and widely distributed over Lewis. The following plants listed in order of importance are representative of the moor:—deer grass, purple moor grass or flying bent, ling or heather, cotton grass, cross-leaved heath, mosses, bog asphodel, carnation grass, heath rush, lesser jointed rush, sundews, &c. Deer grass (50 per cent.), flying bent (20 per cent.) and ling (10 per cent.) together constitute four-fifths of the entire vegetation. The paucity of grasses—a characteristic of deer grass moor—stamps this as poor at once in quality and quantity. This fact is reflected in its low carrying capacity for blackface sheep. Flying bent is the sole representative of the grass family, and the stagnant conditions obtaining are far from conducive to its optimal development. It discards its leaves at the end of the season and is of negligible grazing value during winter, but with the advent of June it develops rapidly and makes a useful contribution during summer and autumn. Deer grass is the dominant species in the vegetation, but as the season advances it browns off and becomes unpalatable. Ling of a diminutive type is widely dispersed among the deer grass. It undoubtedly affords valuable, if not early grazing. Cotton grass occupies the more stagnant areas and performs a useful function in providing keep before the other species come into bearing. Lesser jointed and heath rush are not abundant but valuable for their palatability during winter. Other species apart from cross-leaved heath make no appreciable contribution to the grazing.

Establishment of an Improved Pasture.—The individuals of the association of plants colonising moorland are called upon to make specific adaptation to the existing soil conditions. Aeration is at a minimum. Because of the abundance of water and the associated evaporation the soil is cold; as a result spring sets in late. Moreover, peat is very retentive of water. These factors together with the presence of humic acids greatly depress the functional capacity of the roots, and this renders it difficult for the plant to replace the water lost. Conservation of the limited moisture supply is therefore imperative, and practically all species inhabiting the moor are specialised to meet this end. While in general there is a surfeit of unavailable water, during

[1] Ogg, W. G., and Macleod, A. "Reclamation and Cultivation of Peat Land in Lewis." *Scot. Journ. Agric.*, vol. xiii, No. 2, April 1930, p. 130.

periods of summer drought the peat is liable to excessive baking. Such soils are phenomenally low in bacterial content, while fungal life is negligible. When it is desired to replace the native vegetation, the soil must offer a different and improved set of conditions, since domesticated plants are but ill-equipped for such exacting requirements. Efficient drainage is thus of vital importance in moorland improvement.

Cultural Treatment.—An area extending to about 8 acres of virgin peat was selected for the trials hereafter described. The depth of the peat varied from 3 feet at the top to about 6 feet at the bottom of the field. The ground had been previously drained by wooden pipes. Cultivation was commenced in July 1929 by means of a large rotary cultivator. The surface of the moor was torn into fine shreds to a depth of 9 to 10 inches. Subsequent cultivation proved impossible owing to the nature of the ground, and the tilth obtained from the rotary cultivator formed the seed bed without further treatment. The field was divided into six plots, five of which received lime of some sort, the sixth receiving no lime. A complete dressing of artificial manures was applied over the entire field.

Grass and clover seeds (Table I) were sown on the 16th July with rye as the nurse crop. Owing to the late date of sowing, rye was not an unqualified success, but this defect was more than balanced by the very successful establishment of the herbage species resulting from the reduced competition.

TABLE I.

	Mixture.				
	I.	II.	III.	IV.	V.
Perennial rye grass	13	8	12	4	8
Italian rye grass	1¾	3	4	4	5
Cocksfoot	1¾	6	8	6	6
Smooth stalked meadow grass	1¾	4	...	...	...
Rough stalked meadow grass	1¾	2	1½	..	2
Timothy	2½	5	5	5	8
Meadow fescue	5¼	3	...	6	...
Tall fescue	...	3	..	4	...
Meadow foxtail	...	...	...	..	4
Red Clover (L.F.)	1¾	3	...	...	2
Cornish marl	...	..	2	4	...
Dorset marl	...	...	2	...	..
Alsike	...	...	1	...	2
Bird's foot trefoil	...	1	1	...	2
White clover	5¼	1	...	...	...
Wild white	...	1	1	1	1

As the establishment of pasture on peat has received little systematic attention in Britain, the seeds mixtures were necessarily of a tentative nature. At the outset, however, it may be said that results have far surpassed expectation. Two of the mixtures have yielded herbage not inferior to some of the best

on good land. The following marks (Table II) allotted out of a total of 10, awarded by four independent observers and averaged, indicates the relative merits of the plots after 24 months.

TABLE II.

	Marks out of 10.
Mixture I	$6\frac{1}{2}$
,, II	9
,, III	9
,, IV	4
,, V	$7\frac{1}{2}$
Unlimed plot	2

The Effect of Lime.—The unlimed plots present the most striking feature of the trials. Dominated by a rank growth of ungrazed Yorkshire fog, they stand out in bold relief from the limed plots which are well grazed and green. Yorkshire fog is not represented in the vegetation of the adjoining moorland, except along the edges of the natural waterways. Its presence in the plots is probably due in large measure to wind-borne seeds from this source and to some extent to its inclusion as an impurity in the seeds mixtures. In the absence of lime, the manurial constituents have been rendered ineffective, with the result that of the sown species only timothy has exhibited toleration of the conditions. The meadow grasses, which are excellent "bottom grasses," are poorly developed. Wild white has suffered from the sourness of the soil and lack of nutrients. Owing to the failure of wild white clover and the meadow grasses the "take" has been very patchy. This has enabled Yorkshire fog, which is neglected by stock when admixed with more palatable species and is a prolific seeder, to gain the ascendancy. Sheep's sorrel is also prevalent. The plots are also characterised by an abundance of indigenous moorland plants including deer grass, cotton grass, rushes, heather, cross-leaved heath, tormentil, carnation grass, flying bent, mosses, &c. Of the clovers, alsike and wild white are relatively more successful than red clover, but all are diminutive. The paramount importance of lime in reclaiming moorland of this type, even for the establishment of pasture, is emphasised when limed and unlimed plots are compared.

That even a small dressing of lime exerts a beneficial influence is apparent from examination of the plots which received a half ton of lime. The amount of Yorkshire fog, though still plentiful, is insignificant in these plots as compared with the unlimed plots. Marked decrease is evident also in moorland volunteer plants. The clovers generally have responded fairly well—alsike and white preponderating. All the sown species have succeeded with the exception of bird's foot trefoil and meadow foxtail, which have failed generally. The better tone of these plots is reflected in their well-grazed condition when compared with plots receiving no lime.

The Seeds Mixtures.—*Mixture I.*—Wild white clover was omitted from this mixture in favour of a heavy seeding of the Dutch variety. The amount of white clover showing after two years is surprisingly high, though bulking rather less than wild white in the other plots. This is interesting and lends support to a belief that is gaining ground, viz. :—that wild white and Dutch white differ only in the proportion of long lived sorts which they contain. The white clover remaining in this plot is probably therefore the residue of longer lived types contained in the ordinary white sown. It should be noted that this mixture is situated on the driest part of the field. Timothy has responded well in relation to the amount seeded. Perennial ryegrass features little in this plot; indeed it has failed uniformly in the second year. Meadow fescue has established itself sparingly. It is more in evidence in " Mixture IV," where the soil is damper. Present prices, however, prohibit its inclusion on economical grounds. The meadow grasses have responded extremely well in this as in all plots. They form a compact sole of particular value under conditions obtaining on peat soils. A complete covering of herbage prevents the surface from baking, and suppresses native volunteer species and agressive inferior grasses like Yorkshire fog. The equality of seeding of rough stalked and smooth stalked meadow grass in this mixture affords an opportunity of assessing their relative establishment. Rough stalked represents about 60 per cent. and smooth stalked 40 per cent. of the meadow grasses.

Mixture II.—This mixture and " Mixture III " have yielded the best results. It is characterised by an increased seeding of meadow grasses, timothy and cocksfoot, all of which have been conspicuously successful in the trials. The response of wild white clover is good, but, when compared with "Mixture I" in respect of white clover, its superiority is not so marked as might have been expected. It is possible, however, that the white clover which so far has persisted in " Mixture I " may not withstand the rigorous conditions. Bird's foot trefoil is entirely absent, as in the other plots where it was included. Late flowering red clover made a fair showing.

Mixture III.—Wild white clover is rather more plentiful than in the previous plot as a result of the reduced seeding of meadow grasses. Red clover features more prominently here than in any of the other plots, which fact, taken in conjunction with data from the other plots, suggests that the increase is due to Dorset marl. Alsike is very plentiful.

Mixture IV.—The exclusion of the meadow grasses has resulted in a poor " bottom," and, as might be expected, the plot is being invaded by moorland plants and Yorkshire fog. In the wetter parts, meadow and especially tall fescue are in evidence. The increased seeding of Cornish marl is not reflected in the return. This mixture is decidedly inferior to the others.

Mixture V.—Clovers are more strongly in evidence in this plot than in any of the others, due in large measure to the

increased seeding of alsike. Timothy is very abundant. This mixture was obtained from a source different from that of the others, and appears to have contained dogstail as an impurity. It is very profuse on the plot, but has been neglected by the stock and is therefore "benty." Under certain conditions, however, its inclusion might be justified.

Discussion of Results.—Efficient drainage is of prime importance in undertaking reclamation whether for pasture or arable crops. If the soil is allowed to remain waterlogged, reversion to moorland vegetation proceeds rapidly. This is well exemplified on an area of wet moor which was cultivated, manured and seeded without previous draining. Establishment was never good and the sward is fast assuming a moorland appearance. Next to drainage lime is important. It is required in order to reduce the acidity of the peat to a point where establishment of the better herbage plants becomes possible. Moreover, without lime, the manurial constituents remain inactive. In the trials under review, the response to even so moderate a dressing as a half ton was conspicuous. An impression is prevalent that heath plants are intolerant of manures. Examination of the unlimed plots unmistakably refutes this idea. Rather is it that, under unfavourable conditions, the sown species are unable to compete successfully with the indigenous flora. Under improved conditions, by nature of their growth habits, the former are able to suppress the heath plants. The absence of lime has proved a limiting factor to the successful establishment of the better herbage types on the unlimed plots, with the result that the soil has been taken up by moorland volunteers and Yorkshire fog. The latter is fairly tolerant of acidity and has a well developed faculty for establishment from seed. It is, moreover, little disturbed by grazing animals, when more palatable herbage is available.

It is important to establish a compact sward as expeditiously as possible to exclude ingress of moorland volunteer and other inferior species. The meadow grasses and wild white clover are especially valuable in this respect, and must be regarded as essential constituents in better class seeds mixtures for peat soils. In "Mixture IV," which contains no meadow grasses, the plots are already being invaded by moorland plants. Moreover, the meadow grasses have demonstrated their ability to check the aggressiveness of wild white clover—a point which can also be observed on mineral soils. Rough stalked meadow grass might be exploited more fully to prevent excessive development of this plant. The success of rough-stalked meadow grass is in accord with Stapledon's[1] findings for poor Welsh soils.

Timothy, of commercial quality, was very successful and displayed a greater degree of toleration of acidity than any other sown species. Cocksfoot contributed liberally to all plots, and it is questionable whether its limit of useful inclusion in the

[1] Stapledon, R. G., and Davies, W. "Some Mixture Problems: Competition." Series H, No. 8, Seasons 1921-1928.

seeds mixture is reached at 8 lb. per acre. Dogstail appears to have been fortuitously included in "Mixture V," where it is prominent in the herbage. It assists materially in securing a close sward, but cannot be recommended unreservedly on account of its aggressiveness and its tendency to become "benty" when uncontrolled. Meadow fescue and meadow foxtail feature prominently in continental mixtures for peat soils.[1] In the present trials, however, they have not so far shown to advantage. In the case of foxtail, establishment is naturally low and it probably warrants further trial. Alsike is vigorous in both plots where it was included. Red clover appears to experience little difficulty in establishment, when the peat is suitably treated. It is premature to state which varieties will prove most suitable.

The trials here discussed are to be regarded as preliminary. Certain facts, however, emerge which are unlikely to be voided by future work. Further trials based upon the experience of those described are in contemplation by the Macaulay Institute, and it is hoped that nearer approximation to the optimum seeds mixture for peat soils will be obtained.

In addition to the "intensive" system of pasture development, there undoubtedly exists scope for marginal improvement under the "extensive" system. Drainage would still be necessary on wet peat, but liming and manuring might be carried out on a less generous scale. In the seeding, use might be made of low fertility grasses, as Gilllies[2] has pointed out, instancing "agrostis." Yorkshire fog, it has been observed, grows luxuriantly on the type of peat described, after drainage, with a little encouragement in the form of manures. Although this species has amply demonstrated its toleration of acidity, lime would be beneficial in rendering effective any manures which might be applied. Yorkshire fog is very leafy, to which must be added its capacity for remaining green throughout winter. It deservedly has a bad reputation on good land, but this is not to say that it is incapable of playing a very useful rôle in the economy of inferior land. In its hairy nature lies its main disability. *Could a non-hairy variety be produced, a place amongst "useful grasses," at least for peat soils, might be secured for this species.*

Summary.—1. A scirpus peat has been converted in less than two years into high grade pasture.

2. Efficient drainage is of prime importance in moorland improvement.

3. Natural fertility is very low and applications of nitrogen, phosphates and potash are necessary.

4. But of no avail unless lime is also applied.

5. Lime is also necessary to counteract acidity.

6. A compact "bottom" is essential to prevent ingress of moorland volunteers and inferior grasses.

[1] Ogg, W. G. "Reclamation of Peat Land in Northern Europe" *Scot. Journ of Agric.*, vol. xii, No. 1, Jan. 1929.

[2] Gillies, John. "Reclamation of Mossland in Dumfriesshire." *Scot. Journ. of Agric.*, vol. xii, No. 2, April 1929.

7. The meadow grasses and wild white have proved invaluable in this respect, and must be regarded as essential constituents of better class "seeds mixtures" for peat.

8. Timothy, dogstail, cocksfoot and alsike have responded extremely well.

9. Red clover has persisted into the second year. Inoculation of nodule bacteria has not proved necessary.

10. Attention is directed to the possibility of utilising Yorkshire fog and other "low fertility requirement" species to effect a marginal improvement.

11. Indigenous moorland plants respond to manuring in the absence of competition from aggressive pasture sorts, but this procedure would be of doubtful value in practice.

In conclusion, it must be added that this paper is the outcome of an invitation by Dr. Ogg, Director of the Macaulay Soil Research Institute, who was responsible for the trials, to examine the pasture plots herein described, and the vegetation of the surrounding moor.

THE WHEAT ACT, 1932.

AMONG the various Acts relating to the agricultural industry that have been passed in recent years, the Wheat Act is one of the few that confer a direct pecuniary benefit on farmers.

The objects of the Act, which became law on 12th May, are "to secure to growers of home-grown millable wheat a standard price and a market therefor; to make provision for imposing on millers and importers of flour obligations to make payments calculated by reference to a quota of such wheat and as to the disposal of the moneys thereby received; to provide for such millers being required to purchase unsold stocks of such wheat," &c.

While an endeavour will be made in this article to explain clearly the provisions of the Act, greater emphasis will be laid on those affecting wheat-growers than on those affecting millers and importers of flour.

The Act applies to the United Kingdom, but it will operate mainly for the benefit of farmers in England, who in 1931 produced 94 per cent. of the total output of wheat, while Scotland's share was 4¾ per cent.; Wales and Northern Ireland produced very small amounts. The "Minister" responsible for carrying out the provisions of the Act is the Minister of Agriculture and Fisheries and the Secretaries of State concerned with agriculture in Scotland and Northern Ireland respectively acting jointly, but certain Orders are to be made by the Minister of Agriculture and Fisheries.

In the course of the discussions that preceded the framing and passing of the Act, much was said of a plan for requiring

millers to use a certain proportion, or "quota," of home-grown wheat, but when this plan was closely examined it was found to be impracticable. In the title of the Act the word "quota" is used with reference only to a method of calculation and not to the compulsory use of home-grown wheat. The "quota" is hypothetical, not actual; further reference is made to this point later in this article.

Growers are in fact free to sell their wheat to any one at what price they can get for it, and millers are free to buy any wheat they please at what price they can get it for. But in the month of June in any year the Minister may, on a representation being made by the Wheat Commission, make an Order requiring the Flour Millers' Corporation to buy from registered growers wheat that remains unsold (up to a limit of one-eighth of the "anticipated supply") at a price to be fixed by the Minister after consulting the Wheat Commission,[1] as representing the market price of home-grown millable wheat of fair average quality in the area to which the Order applies. Any question raised by the Corporation as to the nature or quality of the wheat offered to it under such an Order is to be settled by arbitration.

Each registered grower will receive a certain sum in respect of each hundredweight of home-grown millable wheat of his own growing that he sells during the cereal year, if the "average price" of all such wheat is less than the "standard price." This is in effect a subsidy. The money will be raised, not by direct taxation, but by a levy on each miller and importer of a certain amount in respect of each hundredweight of flour he delivers for consumption. This charge will no doubt be passed on by the miller or importer to the consumer.

Two bodies are established to carry out the provisions of the Act. The Wheat Commission consists of nineteen persons appointed by the Minister—a chairman, a vice-chairman and representatives of wheat-growers (5), millers (3), importers of flour (1), wheat merchants (3) and consumers (5). Only the chairman and the vice-chairman may receive remuneration for their services, but other members may receive compensation for loss of time, as well as travelling and other allowances. The members of the Commission have already been appointed, and one of the representatives of wheat-growers is Mr. G. G. Mercer, Southfield, Dalkeith, while one of the consumers' representatives is Mr. A. Buchanan of the Scottish Consumers' Co-operative Movement. The Commission is charged with many duties and will require a considerable staff. Its administrative expenses are to be met out of the funds it administers and not from public funds, and the same applies to expenses incurred by any Government Department on its behalf.

The Flour Millers' Corporation consists in the first instance of five persons appointed by the Minister. After the flour

[1] Many of the Minister's actions are to be taken after consulting the Commission. It is thought to be unnecessary to repeat this phrase throughout the article.

millers have been registered they will elect the members of the Corporation. The main function of this body appears to be the compulsory purchase of unsold wheat mentioned above.

A number of terms used in the Act require explanation. The "cereal year," which is the unit of time for the transactions relating to the crop of a given year, is the period from 1st August in that year to 31st July in the following year. The "average price" is the average price obtained by registered growers for home-grown millable wheat of their own growing sold by them during the cereal year. The "standard price" is 10*s*. per cwt., or 45*s*. per quarter of 504 lb. This figure is subject to revision in 1935.

The "price deficit" is the difference between the average price and the standard price. The average price for the cereal year 1932-33 is estimated by the Minister at 5*s*. 9*d*. per cwt., and the estimated price deficit is therefore 4*s*. 3*d*.[1] The administrative expenses of the Wheat Commission have however to be deducted from the amount available for payment to growers. No estimate is made of the amount of these expenses, but probably the deduction on this account will amount to only a few pence per cwt. The amount ultimately reached is the "deficiency payment," or subsidy.

The average output of wheat per acre in the United Kingdom for the ten years 1921 to 1930 was about 18 cwt. On an output of this amount of millable wheat, less 7½ per cent. for seed, a deficiency payment of 4*s*. per cwt. would amount to about £3, 6*s*. per acre, being 6*s*. more than the amount of the subsidy paid in respect of the wheat crop of 1921 under the Corn Production Acts (Repeal) Act. In Scotland the average output for the ten years was 21 cwt., and the amount payable per acre would be about £3, 17*s*. Owing, however, to the fall in prices that has taken place since 1921, the real value of this sum is greater than it was then.

The "anticipated supply" of wheat is the amount that the Minister estimates will be sold by growers during the cereal year. This estimate is to be made at or as soon as possible after 1st August, and may be varied at any time up to 1st January. The material at present available for the purpose of finally fixing the amount consists of the estimates of production made by the Ministry of Agriculture and Fisheries, the Department of Agriculture for Scotland, and the Ministry of Agriculture, Northern Ireland. In estimating the "anticipated supply" the Minister is to deduct 7½ per cent. for seed, and also that portion of the crop which will be used for feeding animals and poultry, only millable wheat being included. The Minister's estimate for the cereal year 1932-33 is 19,800,000 cwt.[2]

The "anticipated supply," when finally settled, may in certain circumstances determine the amount of the deficiency payments each grower receives. If the amount actually sold by

[1] Wheat (Quota Payments) No. 1 Order, 1932, dated 16th June 1932

[2] Wheat (Anticipated Supply) No. 1 Order, 1932, dated 16th June 1932.

growers is less than or equal to the anticipated supply, the growers will receive full payment. If, however, the amount sold turns out to be larger than the anticipated supply, then the number of hundredweights on which each registered grower will receive deficiency payments will be reduced in proportion. Thus if the anticipated supply is 22 million cwt. and the amount sold for milling is 24 million, each grower will receive payment in respect of only eleven-twelfths of the amount he has sold. It is clear that great care will have to be exercised in framing the estimate of the anticipated supply in order to do full justice to growers.

One of the probable effects of paying a subsidy to the producers of any commodity is an increase in production. The Act limits the liability of the Wheat Commission to growers by providing that if the anticipated supply exceeds 27 million cwt., it shall be reckoned at that figure.[1] The total output of wheat in the United Kingdom in 1931, including that used for seed and for feeding animals and poultry, was estimated at 20,242,000 cwt. There is therefore room for a considerable expansion before this limit operates. The total estimated output in 1927 was about 30 million cwt.; since then there has been a rapid decrease.

The first step that a grower of wheat must take in order to obtain the benefit conferred by the Act is to get himself registered by the Wheat Commission. Forms of application for registration will be issued on behalf of the Commission by the three Agricultural Departments to all who make returns of wheat in the Agricultural Returns for 1932. For this purpose and for other purposes connected with the Act the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland are empowered, notwithstanding the provisions of the Agricultural Returns Act, 1925, to use these Returns.

The registered grower then becomes entitled to make claims on the Wheat Commission for deficiency payments, which must be vouched for by "wheat certificates" certifying that the wheat was home-grown wheat of his own growing, that it was millable, and that it was sold by him on the date specified, and giving the name of the person to whom or to whose order it was dispatched. These certificates will be issued by the Commission on satisfactory proof that the claimants are entitled to receive them, and only after the dispatch of the wheat to which they refer. Registered growers will have to keep records and furnish, when required, returns of *all* the wheat they buy or sell, and of the price at which it was bought or sold.

An important provision is that the Commission may make payments in advance on account of the deficiency payments that will become due. It would clearly be unfair to keep growers waiting until the precise amounts due to them have been calculated on the expiration of the cereal year.

It will be seen that the Act does not provide that a grower

[1] This limitation does not apply to the anticipated supply in relation to the compulsory purchase of wheat by the Flour Millers' Corporation.

shall receive 10*s*. per cwt. for the millable wheat he sells. He is to receive a fixed amount per cwt., which is calculated on the average price obtained by all growers. If he sells above this average price he will get altogether more than 10*s*. per cwt., and if below it he will get less. This is the same principle as was embodied in the Corn Production Acts, 1917 and 1920,[1] which provided for payments in respect of wheat and oats. Under these Acts, however, the payments were actually to be on a basis of acreage, since it was assumed that every grower produced four quarters of wheat per acre and five quarters of oats. Under the Wheat Act a grower will profit by a heavy crop.

As regards change of tenancy, where the outgoing occupier of any land is by law or custom entitled to receive compensation from his landlord or from the incoming occupier in respect of wheat growing or grown on the land, the amount of the deficiency payments, if any, that may become payable in respect of that wheat to the landlord or incoming occupier is to be taken into account in the assessment of the compensation. The terms of this provision are similar to those of Section 3 (1) (*b*) of the Corn Production Act, 1917, which gave rise to much discussion in Scotland in the years 1921 and 1922.

The other condition of change of tenancy is dealt with as follows :—" Where in pursuance of any custom or agreement the outgoing occupier of any farm leaves on the farm wheat harvested by him, then, in relation to any sale of wheat within six months after he has ceased to be the occupier of the farm, the wheat shall, for the purposes of this Act, be deemed to be of his growing and not of the incoming occupier's growing, notwithstanding that the outgoing occupier is not the occupier of the farm at the time of the sale "

The registered grower of wheat sold at a certain time retains his right to receive payment in respect of that wheat although he may after that time have ceased to be a registered grower.

Finally, where wheat of a registered grower's own growing has been poinded and sold by a creditor, the registered grower retains the right to receive deficiency payments in respect of the wheat as if he had sold it himself.

The Wheat Fund, out of which the payments to registered growers are to be made, is to be provided by a levy on flour millers and importers in respect of each hundredweight of their output of flour. This is described as a " quota payment," because it represents what *would have been* the " price deficit " in respect of the quantity of home-grown wheat used in producing each hundredweight of flour *if* a quota system had been in force requiring a certain proportion of home-grown wheat to be used. The " quota payment " is to bear the same proportion to the price deficit as the anticipated supply of wheat

[1] No payment was made under either of these Acts. In the years 1918 to 1920 the average prices of wheat and oats remained above the standard prices, and both Acts were repealed in 1921. The only payments actually made were those under the Corn Production Acts (Repeal) Act, 1921.

bears to the estimated supply of flour delivered and retained for consumption in the United Kingdom.

Any wheat meal sold for animal or poultry food is exempt from the levy, and a miller who produces nothing but this meal can get a "provender miller's certificate," which exempts him from liability. Repayment will be made in respect of flour or bread exported or shipped as stores, where a quota payment has been made in respect of the flour itself or the flour from which the bread was made.

In fixing the quota payment the Minister has to estimate not only the anticipated supply of home-grown wheat but the average price at which it has been and will be sold, the consequential price deficit, and the supply of flour that will be delivered by millers and importers during the year. On the basis of the estimates of average price and price deficit already mentioned, and of an estimated supply of flour amounting to 93,500,000 cwt., the Minister has by Order fixed the quota payment for 1932-33 at 10⅝*d.* per cwt., which is equal to 2*s.* 3*d.* per sack of 280 lb. This Order came into force on 19th June.[1] In consequence of obtaining fuller information the Minister may by Order alter the amount of the quota payment at any time during the cereal year. He may also, in accordance with the state of the Wheat Fund (which may have carried forward a surplus or a deficiency from the previous year), fix the quota payment at such a figure as he thinks expedient, while if the average price becomes equal to or greater than the standard price he may cancel the quota payment altogether. These arrangements are intended to ensure, as far as possible, that the millers and importers shall contribute just what is required to meet the claims of registered growers and the cost of administration.

The quota payments are to be made by millers and importers directly to the Wheat Commission. As has already been mentioned, however, the Flour Millers' Corporation may be required by the Minister to buy unsold wheat from registered growers towards the end of the cereal year. This wheat the Corporation may sell or dispose of, and any profit made or loss incurred on such transactions is to be distributed among or borne by the registered millers in proportion to their output of flour for the year.

The further details regarding the effect of the Act on millers and importers need not be mentioned here, except a transitory provision that, should an Order regarding quota payments be made before 1st August 1932, the "first accounting period" will run from the date of the Order to 31st July 1933, a longer period than the normal cereal year. Action has already been taken under this provision, and the "first accounting period" began on 19th June, as stated above. This provision does not affect growers. It may further be pointed out that the sale of wheat grown before the year 1932 will not entitle a registered grower to receive any payment.

[1] Wheat (Quota Payments) No. 1 Order, 1932, dated 16th June 1932.

At one time it was proposed that a Board should be established under the Agricultural Marketing Act, 1931, for the purpose of regulating the marketing of home-grown wheat. This has not been done, but the Act provides for the transfer of the Wheat Commission's functions to such a Board if it should be established.

Copies of the Act may be obtained from H.M. Stationery Office, 120 George Street, Edinburgh (and the other addresses given on the cover of this JOURNAL), price 6*d.*, or by post 7*d.*, while copies of the Byelaws made by the Wheat Commission may be obtained for 5*d.* or by post 6*d.*

THE STASSANISER.

ANDREW CUNNINGHAM, D.Sc.,

Department of Bacteriology, College of Agriculture, Edinburgh.

DURING recent years increasing attention has been paid by the dairy industry and the milk-consuming public to the question of the pasteurisation of milk. The chief aims of pasteurisation are the destruction of bacteria which may be injurious to the consumer, and the reduction of the total germ content to a point at which the milk will remain sweet for a reasonable period. The problem of pasteurisation is not, however, as simple as this statement implies. In order that the saleability of the milk should not be impaired, it is of great importance that the reduction in the germ content should not be secured at the expense of those properties which are highly esteemed by the consumer. Such properties include nutritive value, appearance, flavour and creaming capacity. The pasteurisation methods, which have from time to time been advocated, vary greatly in their effects upon these properties as well as in their ability to reduce the germ content of the milk.

Methods of pasteurisation may be classified broadly into two groups :—

(1) " Flash " methods, in which the milk is heated to a relatively high temperature (generally 175° F. or over) momentarily or for a very short period.

(2) " Holder " methods, in which the milk is maintained for considerable periods at lower temperatures than those employed in the flash methods. The combination of temperature and time generally in use is 145° to 150° F. for twenty to thirty minutes.

From the point of view of their capacity to reduce the germ content of milk and render it safe for consumption with a minimum destruction of valuable nutritive and other properties, holder methods of pasteurisation are generally considered to be superior to flash methods. In recent years there has been a

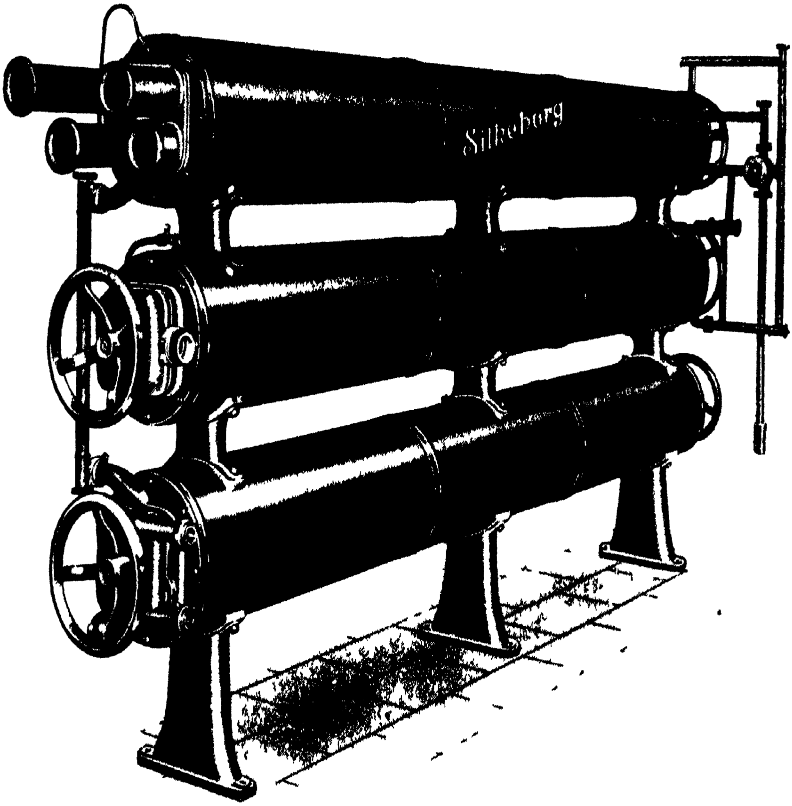

FIG. 1

Stassaniser, showing the inner tubes in the upper section partially withdrawn for cleaning purposes

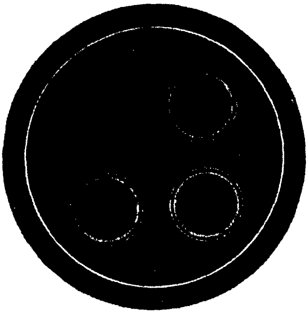

FIG. 2

Cross section of a stassanising cylinder.

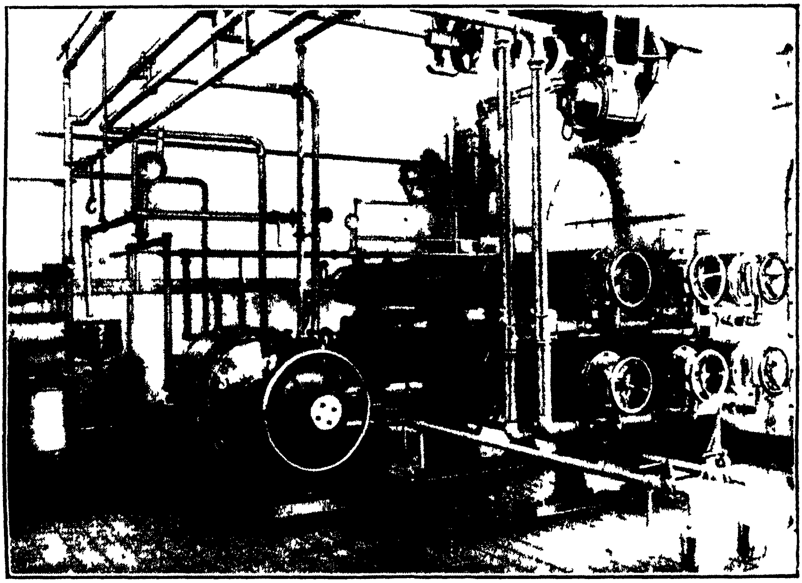

FIG. 3

Stassanising plant, capacity 6000 litres per hour, with six stassanising cylinders and plate apparatus.

growing tendency to discard the latter and to rely mainly upon the former.

During the last twenty years an Italian scientist, Dr. Henri Stassano, working at the Pasteur Institute in Paris and also in Strassbourg, has been investigating methods for the pasteurisation of milk by exposing it in thin layers to the action of germicidal agencies. He has recently succeeded in devising an apparatus, generally referred to as the Stassaniser, for the treatment of milk on a commercial scale. Stassano's process has aroused a considerable amount of interest on the Continent, and in Denmark and other countries a number of commercial plants are now in operation.

In the Stassaniser the milk is heated at 75° C. (167° F.) for about a quarter of a minute in a layer 1 to 1¼ mm. thick. This is accomplished by causing it to circulate through the space between two concentric metal pipes maintained at the desired temperature by means of hot water. In the modern types of the apparatus the tubes are arranged in groups in horizontal cylinders (Figs. 1 and 3). Fig. 2 shows a cross-section of a cylinder containing four pairs of concentric pipes, while in Fig. 1 the inner tubes in the upper cylinder are shown partially withdrawn. In each cylinder the pipes are united in pairs at their ends by a special end-piece which screws into position and permits the milk to be pumped from one horizontal pipe to another and so backwards and forwards through the cylinder.

A stassanising plant may consist of three horizontal cylinders (Fig. 1). In one of these the milk is heated as already described; the other cylinders are referred to as the regenerative and cooling elements respectively. In addition a water heater may be provided. This may consist of a vertical cylinder or may resemble one of the stassanising elements, in which case it is generally placed horizontally. Two pumps are also included in the plant. One of these causes the milk to circulate through the apparatus; the other provides for the circulation of the water in the stassanising unit proper.

The milk is first passed through a strainer and then flows through the inner tube of the regenerative unit. During its passage it is warmed to about 120° F. by the hot milk from the heating unit which is passing through the outer tube of the regenerative element. From the latter the partially warmed milk is conveyed to the milk pump which sends it through the stassanising unit. Here it is heated at the required temperature in the space between the outer and inner tubes. The warm milk now flows through the outer tube of the regenerative unit, in which it is cooled to 85° F. before it is passed to the cooling element. In the latter the milk circulates through the outer tube and is cooled by cold water or brine in the inner tube. In certain of the larger plants the preheating and cooling of the milk are carried out in a plate apparatus as illustrated in Fig. 3.

Stassano and his collaborators attach great importance to the surface action of the heated metal in reducing the germ-content

of the milk. The exposure in a layer about 1 mm. thick and the continuous rapid movement of the liquid through the long pipe system of the Stassaniser both tend to bring a large proportion of the bacteria into intimate contact with the heated surface. Emphasis is also laid upon the fact that in the stassanising process the milk is heated in a closed vessel. In this connection it is pointed out that as early as 1902 Russell and Hastings showed that in a closed container bacteria could be killed at a temperature several degrees lower than that necessary for their destruction in an open vessel.

The heating of the milk in a closed container has several other important advantages. In the first place there is no loss of volume due to evaporation. Exposure to heat in the absence of air also tends to minimise the destruction of the vitamins, which have been shown to be more resistant to heating in the absence of oxygen than in its presence. In stassanisation, losses of carbonic acid gas are largely eliminated. From the nutritional standpoint the conservation of carbonic acid is of importance as it tends to keep the calcium salts and phosphates of the milk in solution. Further, it is claimed that owing to the retention of the carbonic acid there is little or no deposit of "milk-stone" in the Stassaniser. As a consequence the cleaning of the plant is greatly facilitated.

The construction of the Stassaniser also renders comparatively easy its cleaning and sterilisation. When the end-pieces of the cylinders are removed the inner tubes can be withdrawn (Fig. 1). The whole apparatus thus becomes readily accessible to inspection, brushing and cleaning. For cleaning and sterilising purposes cold water, soda solution, hot water and steam can be forced through the plant in succession.

In 1929 the Danish State Experimental Creamery at Hilleröd published the results of a series of experiments with the Stassaniser. The work was carried out during the years 1927 to 1929 by Dr. A. P. Hansen, the director of the Experimental Creamery, with the collaboration of Professor O. Bang of the Veterinary and Agricultural College, Copenhagen, and Professor L. S. Fridericia of the Hygienic Institute of Copenhagen University. In these experiments stassanisation was found to reduce the total bacterial content of the milk by more than 99 per cent. It destroyed the bacilli of contagious abortion in the naturally-infected secretion and also cultures of coliform organisms added to milk. A series of four experiments was carried out with the milk of four cows suffering from tuberculosis of the udder. The milk of these animals was mixed in varying proportions with the creamery milk. It was then sampled, passed through the Stassaniser and sampled again. Guinea-pigs were inoculated with varying quantities of the samples taken before and after stassanisation. The records of these experiments indicate that six groups of animals inoculated with stassanised milk all failed to show evidence of tubercular infection while an equal number of groups of guinea-pigs inoculated

with the untreated mixed milk all became infected with the disease.

The work on the influence of stassanisation on the vitamins of the milk showed that the content of vitamins A and B was not appreciably diminished by the process. Owing to technical difficulties the experiments on vitamin C had to be abandoned. Chemical examination of the milk revealed little or no change as a result of stassanisation. The albumen-and globulin-nitrogen showed a reduction of about 8 per cent. In experiments on the rate of coagulation by rennin it was found that the time required by stassanised was about 13 per cent. in excess of that required by raw milk. The conclusion was reached that, from the point of view of cheese-making, the reduction in renneting capacity was so slight as to be of no practical significance.

Investigations on creaming capacity indicated that in this respect stassanised milk was slightly inferior to raw, but decidedly superior to flash-pasteurised milk. The reduction in the creaming capacity of stassanised as compared with raw milk was attributed to partial homogenisation during passage through the long narrow tubes of the Stassaniser. No change in the appearance, flavour or aroma of the milk could be detected as a result of stassanisation.

In experiments on the consumption of steam the Stassaniser was found to operate more economically than the usual pasteurisation processes. For the treatment of 1000 kg. of milk it was calculated that in the Stassaniser about 45 kg. of steam were required against 100 kg. for holder pasteurisation and 135 to 155 kg. for ordinary flash pasteurisation at 194° F.

It must be admitted that the Danish investigations on stassanisation have yielded promising results.[1] More data are, however, required, particularly on the effect of the process, *operated under commercial conditions*, upon the bacterial content of the milk. This is specially necessary in view of the fact that the general tendency in the dairy industry in recent years has been to depart from flash methods, mainly because of their unreliability in destroying the pathogenic bacteria in milk. Further comparisons with the usual method of holder pasteurisation are also desirable.

I wish to thank Dr. A. P. Hansen for the loan of the blocks from which the illustrations, which accompany this paper, were prepared.

[1] These are, in general, confirmed by the investigations of the Prussian Dairy Research Institute in Kiel. (*Prüfungen an Hoch. u. Momenterhitzern*, 1932.)

THE MANAGEMENT OF GRASSLAND.

J. EVANS GORDON, B.Sc., Ph.D.,
Agricultural Dept., University of Edinburgh.

THE origin of grassland husbandry in this country is lost in antiquity, and it is impossible to say definitely at what time or by what method grassland areas were first treated as a means of increasing the quantity and quality of stock. It is recorded that the first farms to be established, primitive enough, yet with distinct signs of organisation, were situated on the drier uplands where conditions for good pasture were found.

Early man led a wandering life, but when he ultimately accumulated flocks of sheep and herds of cattle he was gradually forced to settle down permanently in one place. He selected the uplands where the pasture was good, and proceeded to extend grazing areas and to improve his stock.

There was, however, little advance in farming until the Romans landed in this country. They recognised the importance of drainage and looked upon the grazing of land as the most profitable element in farming. Furthermore they appreciated the necessity of having as rich a pasture as possible. They burnt their herbage during August, thus destroying fibrous, unnutritious stems, and encouraging the growth of young succulent plants. The Roman system of haymaking seems, too, to demonstrate the same principles as our present day practice. The meadows were commonly cut twice, in May and in August or September. The second cut is recorded to have provided softer sweeter hay than herbage which reaches its full growth. They left the grazing with no roughnesses, i.e. they kept down the indigestible fibre content of the pasture.

During the Norman period sheep became extremely important. Wool was the outstanding agricultural product, and specialisation in this coincided with the development of the enclosure system. Good quality herbage no doubt was the outcome, but records, indicating improvement in grassland management, are difficult to find.

The next great development did not come until the eighteenth century but it was of a revolutionary character, in the form of the introduction into Britain of two new crops, turnips and clover, and the consequent establishment of the famous Norfolk four-course rotation. The new crops and the rotation brought about greater fertility, and therefore a big advance took place in the direction of grass improvement. Grass and clover seed mixtures were sown down and the grassland scheme now consisted of :—(1) young grass produced from a year's temporary grass and clover seed mixture; (2) meadow land for hay and grazing; (3) permanent grassland; (4) hill grazings. It was not, however, until well on in the nineteenth century that a wide range of grass and clover constituents became apparent.

When improvements in agriculture began in Scotland and sown grasses were introduced, bog meadows became of less value.

These meadows in time were converted to arable land, and draining, cleaning of the land, liming and manuring were introduced. Developments came slowly, but the tendency was to establish grassland management as a science. From this point there gradually appeared developments in the direction of the manuring of grassland and the compounding of grass and clover seed mixtures. Such problems as the following stood out as important during the latter half of the nineteenth century and the first decade of the twentieth :—

1. A desire to acquire greater knowledge concerning the more important grass and clover species, particularly with regard to their length of life, palatability, yield and behaviour when grown in company with other species. The problem of trying to relate species to other conditions of environment such as soil and climate is much more recent.

2. The response on the part of permanent pasture to manuring, particularly phosphatic manuring. Basic slag and ground mineral phosphate were found to be valuable sources of phosphoric acid because they are basic in reaction and do not use up lime in the soil, and because they are relatively cheaper per unit than superphosphate, which is acid in reaction and depletes the soil of lime.

3. The stimulation of herbage growth by rational cultivations. Attention was given to the form of implement or implements that would produce the greatest beneficial response on the part of the herbage.

4. The increase and control of the nutritive quality of existing pastures by some well thought-out system of grazing.

Such problems as these led up to the most recent phase in the development of grassland science, and to-day an attempt to review exhaustively from an international or national standpoint the scope of research in grassland involves one in an extremely formidable task. The subject has been studied in Sweden, Denmark, Germany, New Zealand and Britain.

Seeds Mixtures and Sowing Down.—After a close examination of the trials which have been conducted up and down the country, one is led to the conclusion that the best results can be obtained from simple mixtures. The species of most importance are the basal species :—perennial rye grass, cocksfoot, timothy, rough stalked meadow grass, late flowering red clover, wild white clover, and in addition Italian rye grass, broad-leaved red clover and alsike.

More than ever has it been shown that there is considerable competition within the mixture, and it is increasingly important to see that no ingredient is present to the exclusion of any of the others. Italian rye grass and also perennial rye grass tend to suppress red clover in the hay and very heavy crops of hay tend to suppress wild white clover. The smaller amount of red clover,

however, may assist in keeping the mixture open, and will certainly encourage the establishment of the wild white clover. Excess of red clover leads to poor establishment of the wild white clover constituent. Furthermore, well-established wild white clover will be very beneficial to grass constituents in the pasture later. It may have the effect of prolonging the grazing period of the herbage by increasing the density of the foliage and retarding hardening of the stems. The three constituents rye grass, red clover and wild white clover are, therefore, very intimately connected, and the problem of preserving balance in the herbage is extremely difficult.

With regard to rates of seeding, it has been found that there is no direct relation between the weight of hay produced and the amount of perennial rye grass sown. A small quantity of perennial rye grass seed may produce as much of this grass in the hay as a much greater quantity would; and furthermore, much perennial rye grass seed produces neither abundant nor prolonged pasture in the second and third year. The best functions of Italian rye grass are realised under conditions where the object is to graze the young grass with sheep or other stock during the late autumn and winter or where it is necessary to have an early spring bite before the herbage is put up for hay. It is an extremely valuable species where sown alone or as the chief ingredient in a mixture to be cut green during the summer. If it is liberally manured a number of cuts may be got from it during the season.

The nature and the time of sowing of the nurse crop may have a profound influence on the "take" of grass. A better sole of grass may be got where early sowing of the nurse crop is practised. Late sowing may suffer from drying out of the seed bed and partial failure of the grass. Early sown cereals can be harvested earlier, and thus the grass and clover seedlings will receive a good start in the seeding year. On the other hand, in late harvesting lodging of the nurse crop may occur with consequent rotting of grass and clover plants. Different varieties of oats may influence to varying extents the proportion of red clover in the hay crop. Profusely tillering varieties like Sandy have a greater suppressing influence on red clover than the more modern, less profusely tillering types like Record. A sound policy is to sow the nurse crop thinner than is usual in order to encourage the development of the grass, and particularly the clover.

In rotation experiments, where different manurial treatment has been given to the previous root crop, the effect on the hay has been quite marked. Where no dung was given to the root crop, the hay crop was poor and contained very little red clover. Where dung alone was used, a distinct improvement was observed and red clover was in greater evidence. Improvement increased with increase of dung. Where dung and complete artificials were combined, there was a further decided improvement and there was much red clover. The succeeding pasture

was affected in the same manner. These findings apply equally well to wild white clover.

Influence of the time of cutting of the hay on the succeeding pasture has been, time and again, well demonstrated. In relatively early cutting, the subsequent grazing usually shows a much better proportion of clover than where the hay crop is cut late. The advantage of earliness of cutting can hardly be over-emphasised.

From a great number of researches that have been carried out in many countries and particularly in our own, two discoveries have emerged which are already having very far-reaching effects. The superiority of indigenous types over cultivated types of grasses is now well recognised; and in addition the necessity for the differentiation between species for hay and species for pasture is now accepted. Pasture types of grasses which grow far into the year and which are long-lived are now at the disposal of farmers. These types are not suited for hay purposes. Pedigree in grasses is now receiving the attention it ought to have. The other point of importance is that of nationality or origin of clovers. It is now firmly established that varieties of red clover produced in this country are better for our conditions than imported varieties. The native clovers are well adapted to our soil and climatic conditions; they yield better and are more persistent. The general indication is that English and Welsh red clover seed is best, while of the imported types, New Zealand and Swedish are the best suited to our conditions.

The farmer can control many important factors in respect of increasing yield and quality of both hay and pasture. Factors such as cultivations, drainage, liming, manuring, quality of seed and resistance to disease are already familiar. There are numerous factors, however, which may influence production about which little is known. There is evidence available, for example, that the crops within the rotation influence one another. It has been shown that the hay crop from seeds sown down with barley which was taken after a potato crop was much bigger than the hay crop from seeds sown down with barley which was taken after roots. The red clover in the former case was in much greater evidence than in the latter.

Manuring for Hay and Pasture.—Four questions are involved. These are:—1. The particular kinds of manures to be used. 2. The time of application. 3. The quantity to apply. 4. Repetition of manuring. It has been already shown that where dung was applied to the previous green crop, the hay crop was good, the red clover constituent was well developed, and the resulting pasture of excellent quality and yield. Amongst the mineral manures there is much variety, and the forms to use will, in the main, depend on the time of application, the condition of the soil and the price of the manures. Where there is a distinct tendency to sourness, it is good policy to use either basic slag or ground mineral phosphate in place of superphosphate, and to apply these at a time which will allow of a considerably long

period of action and interaction in the soil before the young crop is ready to make use of them. Potash may be given either along with the phosphates in mixture or the phosphates and potash applied as a mechanical mixture, e.g. potassic basic slag or potassic mineral phosphate. Nitrogen is usually applied in a readily available form in the spring of the first harvest year and at subsequent periods in the life of the pasture.

Manuring for hay and grazing may be carried out during the rotation, at the end of the seeding year or in the spring of the first harvest year. Rotational manuring has much to recommend it. It consists of applying the phosphates for the hay to the previous root crop. If this method is adopted the cheaper, slow-acting phosphates can be used. The following barley or oat crop will receive a liberal dressing of phosphates in the form of slag. In the spring of the first harvest year, the herbage will require a dressing of quick-acting phosphate. These remarks apply also to potash, where potash is necessary. The following quantities may be recommended :—5 cwt. of basic slag to the root crop with 3 cwt. of potash manure salts (30 per cent.) where needed; 3 cwt. basic slag to the cereal crop following, with or without potash; and 2 cwt. superphosphate to the young crop in the spring of the first harvest year with or without 2 cwt. potash salts. Nitrogen in the form of nitrate of soda, nitrate of lime or nitro-chalk may be applied at the rate of 1 cwt. per acre in the spring of the hay year.

It is more customary, however, to apply the phosphates and the potash to the young grass at the end of the seeding year. A dressing of 3 cwt. of ground mineral phosphate along with 2 cwt. of potash manure salts (30 per cent.) per acre may be recommended with the usual application of quickly-acting nitrogenous manure in the spring of the hay year.

The third method is to apply the manures in the spring of the hay year at the rate of 3 cwt. of superphosphate along with 2 cwt. potash manure salts and 1 cwt. of a quick-acting nitrogenous manure per acre.

With regard to lime, this material is of considerable importance. The constituent which responds to liming to the greatest extent is red clover. Where necessary to control acidity, the application of lime secures a decided response on the part of the herbage. Where there is a tendency to sourness, the substitution of manures with a basic reaction for those acid in reaction should be kept in mind.

In connection with further manurial treatment throughout the life of the pasture, the best guide will be the condition of the grazings, and this will depend on the treatment they receive in respect of nature, regularity and intensity of grazing. Generally the pasture can be left untreated for from three to five years, and then a dressing of 5 cwt. of basic slag or its equivalent as ground mineral phosphate, along with 2 to 3 cwt. of potash salts where required, may suffice. To stimulate growth, 1 cwt. per acre of a nitrogenous manure may be applied in the spring.

Nutritive Value of Unmanured and Manured Pastures.—Only within recent years has the important question of the chemical composition and nutritive value of pastures been pursued with any thoroughness. It has been shown that pasture has two peak periods of yield per annum, the first during April-May and the second approximately during the early part of October. This behaviour is very closely correlated with rainfall. On analysing samples of pasture grass it has been found that, compared with hay, the herbage is rich in protein and low in fibre during the first maximum or peak period in the spring, that during the dry mid-summer season there is a slight decrease in the protein content and a corresponding slight increase in the fibre content; but that during the second maximum or peak period in the autumn, the herbage recovers its high protein and low fibre content. This applies to well-grazed pastures. Such herbage is highly digestible; it may be looked upon as very similar to a concentrate such as linseed cake and it possesses a very narrow nutritive ratio. On account of the latter characteristic, such herbage may not be balanced for all classes of stock. It is suitable for such stock as milking animals and young grazing stock, but unsuited to animals demanding a much wider nutritive ratio. The nutritive ratio must therefore be controlled by rational grazing or by supplementing the herbage food with a food not so rich in protein but relatively rich in carbohydrates, e.g. home grown cereals. Home grains are important from another standpoint. During the dry mid-summer season the lime content of the pasture increases to a maximum and falls off in the later months of the year, whereas phosphate shows the reverse behaviour. Where grazing has to be supplemented during the summer season, this can be done by means of cereals since they contain considerable phosphate and less lime.

Trials have been conducted under systems of weekly, fortnightly, three-weekly and monthly cuttings. The conclusion has been that in respect of digestibility and nutritive value, a system of rotational grazing, where the grazing periods are one month in duration, provides herbage which conforms to the desirable characteristics outlined above, i.e. if growth is rapid, digestibility will be high, except for the slight depression during the dry mid-part of the season; if drought is prevalent, growth will be slow and the pasture will tend to become fibrous and wiry. This is the reason for the interval of one month which is allowed between successive grazings in a system of rotational grazing.

When the pasture is subjected to a relatively intensive system of manuring, as in the intensive system of grassland management, the various findings in the case of the unmanured pasture are confirmed, and the same precautions as to supplementing the grazing with carbohydrate-rich foods are emphasised. The manured pasture yields more herbage than the unmanured. In this connection the effect of repeated dressings of sulphate of ammonia to pasture is receiving detailed attention. It has been

suggested that the improvement brought about by the application of soluble nitrogen may not be very great during the first two seasons of application. The greatest increases in the yield of pasture grass probably occur early in the grazing season. It is consequently suggested that one dressing of a nitrogenous manure like sulphate of ammonia might, with advantage, be substituted for the numerous smaller dressings used at periods throughout the season. The considerable advantages in such a procedure are readily apparent. The effect of manuring, however, is most marked on the lime content of the grass, the pasture receiving nitrogen containing less lime than that which received no nitrogen.

Since it has been shown that short pasture grass is a richer food than the best hay and that it is highly digestible, means have been sought of converting surplus herbage into a form capable of being stored during the winter, without deterioration in nutritive value. Three satisfactory products have been the result, namely, grass meal, which is just the short herbage cut and dried, and grass cakettes, which are made from young grass dried in steam-heated troughs and pressed into cakes by hydraulic presses. The latter product, when soaked in water, swells and breaks up. It retains its green colour and its characteristically pleasant odour. Tests have shown that where grass cakettes were substituted for concentrates in the rations of sheep, cattle and dairy cows, as satisfactory results were obtained as with linseed cake. The third grass product is silage. The feeding of grass silage to dairy cows has been practised for a considerable time, and it is possible, if ordinary precautions are taken, to feed a product which will be accepted readily by stock and which will not seriously affect the milk yield of dairy herds. The difficulty sometimes experienced in disposing of surplus grass and certainly the difficulty of securing both first and second hay crops in good condition in certain districts urge the necessity of giving this silage project a trial. Grass silage has been successfully made in a stack from aftermath. The pit method has also been used with success, the material ensiled being grass cut at the flowering stage where the conditions were unsuitable for the making of hay. The digestibilities of both stack and pit grass silage compare favourably with those of good hay except that the protein may show a slight decrease. It may be sounder policy to make grass silage rather than run the risk of producing poor quality, unpalatable, dangerous hay. Good quality silage can also be produced from permanent pastures which have been allowed to grow to the flowering stage. The green material contains practically no clover and yet gives a silage of high nutritive value.

The mineral content of pasture grass is another problem of great importance and much work has been done in this connection. For example, pasture analyses have revealed that serious mineral deficiencies occur in large pastoral areas and that these areas have high stock death rates. The analyses of

numerous samples of pasture grass, from several areas in the British Isles, show that the grass from hill areas is usually much poorer than that from cultivated areas in respect of phosphate, potash and the like as well as in nitrogen. Where samples taken from sheep-grazed sections were analysed it was found that these, whether from cultivated or hill areas, showed a higher proportion of nitrogen, phosphate and potash. As far as sheep are concerned they seem to be able to differentiate between mineral-poor and mineral-rich herbage. The influence of manuring seems to be varied, and the constituents which show the biggest variations are lime and potash and to a lesser degree phosphate. Where there is an increase in lime there is usually a corresponding increase in nitrogen.

Grazing.—The subject of grazing is an extremely controversial one, but there are a number of important fundamental facts which it is always well to bear in mind. These concern the grazing season, the grazing animal and the herbage to be grazed. With regard to the grazing season, very heavy grazing early in the year will have an adverse effect on the persistency of the grasses which start growth early, such as cocksfoot. The palatability of such types may increase the damage. There are, however, two remedies for this, namely, the use of good herbage strains and a sound manurial scheme. The danger will be most marked on light soils. As far as summer grazing is concerned, it is well to remember that the shorter the herbage is kept the more nutritious it will be. Spring grazing must be so organised as to prevent the tendency to rankness, to ensure high palatability and high nutritive value. Grazing must not be allowed to become selective. During the summer the aim is to prevent, by varying the density of stocking, the tendency of the herbage to run to seed. The shorter the pasture is kept during the summer, the greater the chance of preventing high fibre content in the autumn. Allowing pastures to run to seed in order to have a plentiful autumn and winter foggage is uneconomic and unsound.

Difficulties, of course, at once arise, and these lead to the conclusion that the grazing policy should not be haphazard, but should be organised on a rotational basis. In this connection temporary grass should be looked upon as a means of supplementing the ordinary pastures during the winter and very early spring and in the drier months.

The grazing animal, both as regards type and numbers, has a profound influence on the quality and quantity of pastures. Sheep graze mainly the fine thin grasses, so that wherever there is selective grazing there is produced a fibrous, unpalatable, undigestible herbage. Mixed stocking is essential, sheep and cattle dove-tailing into each other, so that rough, tufty herbage is kept down by the cattle and the finer grasses suitably exposed to the sheep. The scheme of the farm may not permit of the best proportions of cattle and sheep and the working plan may be very much one-sided. It will still be good policy to aim at

short, non-fibrous herbage, and this can be done through the agency of the mowing machine. This machine is an important means of keeping down rough grass and of introducing a method of rotational control by means of which it is possible to have high quality pastures during the different periods of the year.

Mechanical Treatment of Pastures.—The foregoing suggestions will not lead to successful grassland management unless the ordinary principles underlying growth and development are observed. The herbage, particularly of old pastures, from time to time needs ventilating as also does the soil. Fresh air and water are necessary and give new life to pasture land. Furthermore, for manures to have their full effect, they require to be in contact with the soil particles. It is useless to apply manures to a dense mat, through which they may never penetrate. And again for the success of the renovating of old pasture, seeds must have soil in which to germinate. It is possible to observe the ordinary principles enumerated, by the use of some type of cultivating implement and by an efficient system of drainage. The lighter types of ordinary cultivator may be used in cases where the density of the mat is not great and where the soil can be seen. In other cases, the heavier and more thorough-going the implement, the better, despite the fact that it may produce an unsightly condition. Cultivations of pasture land fit well into the labour scheme of the farm since they are carried out during a period of the year when general farm operations are less numerous and work is not so intense.

Summary.—The present day conception of a sound grassland policy will embody the following important points.

In respect of mixtures, simplicity is one of the keynotes to success along with a study of the conditions and the purpose or purposes for which the mixture is to be sown down. Particular attention should be paid to strains within the species. If specialisation is to be made in grazing herbage it will be necessary to use early leafy persistent strains of grasses. The nationality of clovers is of great importance. It is advisable to use, in preference, home raised seed and of the imported kinds, New Zealand or Swedish.

Excessive quantities of rye grasses will tend to depress the clovers and thus influence negatively the quality of the hay and the grazing. Italian rye grass is an extremely robust, fast grower and may suppress red clover to a considerable extent.

If a good take of grass is aimed at, and ultimately good grazing, it is sound policy to give a thinner seeding of the nurse crop than is usual, to sow it early and get it off the ground as early as possible. This means that there is more chance of the young seedlings thoroughly establishing themselves in the seeding year. For good takes of grass, grain-producing varieties of oats allow of better development.

Manuring is of outstanding importance and whatever system is used, either applying the phosphate and potash in excess to the previous root crop for the hay and pasture later on or applying

these constituents direct to the young grass in the autumn of the seeding year or in the spring of the hay year, it is a sound policy to give a sufficient and balanced dressing of artificials which will influence beneficially both hay and pasture. Dung, in addition to artificials, gives the best results.

Early cut hay is more nutritious than late cut hay and obviates the risk of the depression of the grasses and the wild white clover.

The dry matter of pasture kept short by rational grazing is a concentrated food stuff, rich in protein and comparatively low in fibre. There are seasonal changes in composition, and it is necessary to organise the grazing scheme so that there will be as even a supply as possible of rich herbage available throughout the whole of the grazing season. It should be noted, however, that such herbage is an unbalanced food for many classes of stock, and it may be necessary to restrict grazing in cases where excess of protein is supplied by such pasture or to supplement the grazing with foods relatively rich in carbohydrates. Furthermore, the type of herbage under discussion possesses relatively high amounts of phosphate and lime.

It is possible to convert young herbage into a form of food suitable for winter storage, e.g. grass cakettes, grass meal. The ensiling of grass and clover or grass alone is practicable and would seem to have great possibilities.

Salient points in the practice of grazing may be summed up in a few words. In order to lengthen the grazing season, i.e. get earlier pasture in the spring and later grazing into the autumn, a system of nitrogenous manuring along with balanced phosphates, potash and lime will give the desired result. Rational manuring will counteract the bad effects of heavy grazing in the spring. On the other hand, if grazing in the spring is too light, the summer period will present difficulties. During the summer it is necessary to keep down the tendency of the pasture to become coarse, wiry, fibrous and unnutritious.

Grazing on a rotational basis is worth careful thought, and in addition the use of short period leys of Italian ryegrass may also be found to be advantageous.

The best results are got by mixing sheep and cattle in the grazing scheme. If this cannot be done in the proper proportions recourse may be had to the use of the mower for keeping down roughnesses in the pastures and so preserving a palatable, nutritious and plentiful bite.

Grassland requires mechanical treatment and an efficient drainage system in order that air and water may be kept in circulation in the soil and around the roots of the herbage plants and in order that manures may have their full effect. Shallow swards need less severe treatment; deep tough mats, severe treatment.

The high quality of pastures cannot be maintained by adopting any one of these suggestions. The policy is a complex one. It will be necessary to give careful attention to all of the points outlined.

INSECT PESTS.—No. XV.

R. STEWART MACDOUGALL, M.A., D.Sc.

IN continuation of the Two-winged Flies of Cereals there remain for mention the Frit Fly and the Gout Fly.

The Frit Fly (*Oscinella frit*).—This is a serious enemy of oats in Britain, on account of the complete destruction of young plants from spring-sown oats, from the weakening of attacked plants that may survive but without producing ears, and from the actual destruction of the grain in the ear. Occasionally wheat and barley are attacked in Britain, but not nearly so commonly nor so severely as in some other countries. A number of grasses may also act as host plants, one of the troubles being that the winter generation is chiefly carried over, until May of the next year, by frit larvæ or maggots that pass the winter in cultivated and weed grasses. The fly is a small one-eighth inch long insect, shining black in colour, and with a wing-spread of about three-eighths of an inch. A careful observer will see the flies in May and June on the young oat plants or on flower heads of other plants in search of nectar; they will be observed more easily and sometimes in numbers, on the outside of stacks in autumn, and occasionally in swarms from oats being threshed or recently threshed. As regards this last I recorded a case where an exposed sheet of white paper smeared with gum was in a minute or two completely covered with a black mass of trapped flies.

Taylor describes the flies as "moving about in leisurely fashion, occasionally taking short flights from one leaf to another, rarely exhibiting much energy, and frequently remaining stationary until the observer's patience is exhausted."

The egg of the Frit Fly, a mere speck on the plant to the unaided eye, tapers towards the front end; on magnification the outside shows a series of longitudinal ridges and grooves.

The egg hatches by a slit at the front end, a pale larva crawling out; in the course of its growth the larva, whose business is feeding, moults twice, so that three larval stages are distinguished. The differences between the first and the two last stages are microscopic, the most marked being the absence of anterior breathing pores in the first stage larva, and also the presence of only two breathing openings to each hind spiracle instead of the three found in the second and third stage larva. The larva is legless; white to begin with and yellow later; has two minute antennæ, cutting mouth-hooks and a grater or scraper; it is more tapering in front, and behind are two projections which have at their tips the hind spiracles; the body is 11-jointed, and the length of the full-fed larva on an average one-eighth inch.

When full grown the maggot moults its skin or outer covering; this moulted skin hardens into a red-brown case under cover of which pupation takes place, the pupa developing into the fly, which escapes from the hard case by a break at the front end continued for a little way down each side. The puparium measures on an average only 2·8 mm. in length (25 millimeters

make an inch), but under magnification the two hind projections of the old larva are conspicuous, this being an aid in recognising the species.

The length of a cycle from egg to adult varies with the temperature and moisture conditions, and the nature of the feeding material. Cunliffe from a series of experiments and observations gives the periods between the emergence of successive generations as 50 days in spring, 35 days in summer, and 230-250 days in winter.[1]

Life History and number of Generations.—It is possible that the number of generations in a year may be more than three, and from the length of life of some females kept in confinement it is even possible that a single female may give rise to two broods, but the story of the Frit Fly is easiest to follow if we take what we know with certainty, viz. that the farmer is concerned with three generations—a spring generation, a summer generation and a third generation in late autumn, whose larvæ pass the winter as larvæ and pupate in the next spring; these wintering larvæ seem hardy and resistant to cold as Baranov in Russia has taken them in winter, unharmed, from plants that were snow-covered.

The first Frit Flies of the year are found in May, or it may be the end of April, and the females lay their eggs on the young spring-sown oats. These flies have come from the pupæ of the winter larvæ and can be found in flight through May and June. For some time after mid-May the flies are numerous and the attack worst. The eggs of the spring flies, sometimes one at a time, sometimes more, are laid within the lowest leaf-sheaths of the young plant; they are introduced by the protruded narrow end of the abdomen of the female modified for egg-laying (occasionally eggs are laid on the outside of the plant). The maggot that hatches cuts its way inwards to the growing point of the young shoot and feeds there;

[1] A considerable amount of intensive work has been done in recent years in Britain on the Frit Fly. The student should consult:—

(1) The Frit Fly on Oats. By T. H. Taylor, Department of Agriculture, The University, Leeds, No. 108 of the University of Leeds and the Yorkshire County Council for Agricultural Education.

(2) Preliminary observations on the Habits of *Oscinella frit*. By Norman Cunliffe in *The Annals of Applied Biology*, vol. viii, Aug. 1921.

(3) *Oscinella frit*. An investigation to determine how far varietal differences may influence infestation of the Oat Plant. By N. Cunliffe and J. C. F. Fryer. *Annals of Applied Biology*, xi, Nos. 3 and 4.

(4) Studies on *Oscinella frit*. A Report on certain Oat Varieties in relation to their resistance to attack by the Frit Fly in Sweden, together with data concerning the production of resistant utility varieties. By N. Cunliffe in *Annals of Applied Biology*, vol. xvi. No. 1.

(5) Studies on *Oscinella frit*. Comparative records of Oat Grain infestation in Sweden during the year 1927, together with a note on Sterility or "Blindness" of Grain. By N. Cunliffe in *Annals of Applied Biology*, vol. xvii, No. 3.

(6) On the structure of the immature stages of the Frit Fly. By A. Steel, M.Sc., in *Annals of Applied Biology*, vol. xviii, No. 1.

Attention is also directed to a series of observations, recorded with great thoroughness, by the late Dr. W. G. Smith, of the Edinburgh and East of Scotland College of Agriculture, in the *Transactions of the Highland and Agricultural Society*, 1912.

The larva is a legless maggot, yellow-white in colour, and with cutting mouth-hooks; full grown it measures just over one-fifth inch. The last moulted skin of the larva remains to form a brownish pupa case under cover of which pupation takes place and the fly is developed. The puparia or pupal cases are always on the food plant and in the neighbourhood of the place of feeding.

Life History.—The first Gout Flies of the year appear about the end of May, and, after pairing, the females lay their eggs on the upper surface of the leaves of the spring-sown barley, one egg as a rule to a leaf. The larva on hatching moves to the centre of the shoot, and reaching the young ear proceeds to eat its way down one side of it and continues to eat out a groove down the side of the short internode that bears the ear. The gnawed out channel deepens with the growth of the descending larva. Full grown, the larva turns round and moves upwards for a shorter or longer distance and then pupates. The new generation of flies from these pupæ come away from August onwards. Barley that has been infested and stacked may show the flies in great numbers round the stacks. The possible results of the work of the larva just described is a stunting of the shoot due to failure in growth of the uppermost internodes, a distortion of the uppermost leaf or leaves, a spoiling of the ear, and it may be the failure of the ear to break its way out from the leaf that ensheathes it.

As a variant of this summer damage we have examples when plants not so fully grown as the last are attacked, when the stem is unelongated and the ear is very small. Attack in this stage is characterised by a stunting of the stem due to the lack of growth of the internodes and a consequent crowding of leaf-sheaths; the leaves are twisted, broadened and thickened. Still again as a variant in the summer attack, should the egg be laid on a fairly well-grown plant but the larva on passing inwards fail to reach and tunnel the ear, the ear will develop and the larva possibly die for lack of nourishment, its mouth-parts not being able to break through the tougher lower internodes.

The August and later flies (mentioned above) lay their eggs typically on couch grass (*Agropyrum repens*)—the eggs can be laid on volunteer or winter sown cereals—and the larvæ hatch out and pass the winter and early spring on such plants, pupating in spring. From these pupæ adults come away at the end of May, the brood with which we began the life history.

The shoots harbouring the winter larvæ show typically as stunted plants, with very poorly developed internodes and therefore crowded together leaf-sheaths; the leaves are broadened and thickened and the crowded sheaths give a swollen gouty appearance to the shoot, which withers away when the enclosed larva pupates.

The cultural method of control is early sowing in districts and on soils where this is practicable.

The mention of couch as the favourite host plant in winter carries its own warning.

A very interesting point brought out by Frew in the Rothamsted experiments was the influence of manures in relation to the summer attack of Gout Fly. Superphosphate and farmyard manure acted beneficially by reducing the summer infestation. Their value was due to the stimulating effect upon the growth of the ear-bearing internode and the maturing of the ear. But large dressings of nitrogenous manure may retard growth of the ear and so increase infestation.

Imms in his Ministry of Agriculture article adds :—" The value of these (Rothamsted) results requires testing under ordinary farm practice and on different soils."

But " the application of nitrogenous fertilisers in order to stimulate an infested crop to outgrow attack is useless; once the Gout Fly has attacked the barley, no remedy is available."

Root and Underground Stem Maggots.

Our review of the Order Diptera may be closed by a short reference to three troublesome maggots, the Cabbage Root Fly, the Onion Fly and the Carrot Fly.

The Cabbage Root Fly (*Chortophila brassicæ*).—This is a grey or ash-grey bristly fly not unlike the common house fly; it measures one-quarter inch in length and is very bristly. The elongated oval eggs are white or cream white, and though very small are readily noticed on plant or soil once the eye has become accustomed to them. The larva is a legless maggot with pointed end provided with cutting moult-hooks; the hind end is thicker and truncate; round the edge of the last joint are twelve small fleshy projections; the two lowest of these are larger than the others and forked at their apex; full grown the maggot measures about one-third of an inch. The pupa-case or puparium is light or dark brown in colour and barrel shaped.

C. brassicæ is an enemy of cruciferous plants; the larvæ attack the underground parts of cabbage, cauliflower, brussels-sprouts, turnip, radish, also of garden flowering plants, and of weeds like hedge mustard and shepherd's purse. Sometimes above ground parts are attacked, the maggots mining into fleshy leaf and swollen leaf stalk and thickened stem.

The first flies of the year issue in the end of April and in May from puparia that have overwintered. Eggs are laid in crevices in the soil near the growing plant, a not uncommon place being the hollow round the stalk of the plant due to the action of the wind; sometimes the eggs are laid on the plant itself about ground level.

The maggot from the egg feeds at first externally, breaking the epidermis with its horny cutting mouth-hooks, but as it grows it may tunnel into and through the cortex with the result that the attacked root becomes a decaying mass and the plant dies away; in the case of less strong attack the plant may survive but

remains weakly and poor. The full grown larva pupates under cover of its last moulted skin, which dries and hardens into a brownish pupa-case; these pupa-cases are found beside the plant attacked.

There can be three generations in the year with considerable overlapping of the generations. The winter is passed in the puparium stage.

Control.—As a deterrent to egg-laying a cupful of paraffin is added to a pailful of sand and the sand sprinkled once a week round the growing plant.

Smith[1] had considerable success with two deterrents, viz. creosote and chlor-cresylic acid applied as dust in a 1 per cent. mixture with precipitated chalk; the preparation in each case was dusted along the rows of plants before the flies had laid their eggs; the treatment was repeated three times at intervals of a fortnight.

Corrosive Sublimate.—The most popular treatment of the Cabbage Root Fly in Canada and the United States is by a solution of corrosive sublimate, a treatment which has thoroughly justified itself in practice. The experimental records of Miles,[2] Maldwyn Davies[3] and Edwards[4] in Britain confirm the American work.

The strength of the corrosive sublimate solution to be used is 1 ounce to 8 gallons of water. The soil round the plant has to be thoroughly wetted; the cavity in the soil surrounding the plant due to the action of the wind on the plant should receive a supply of the solution. The solution should not be poured *on* the plant. The first treatment should be five or six days after planting out, and three further applications should follow at intervals of a week.

As regards corrosive sublimate emphasis has to be laid on the following :—

(*a*) It is a dangerous poison to human beings and to all animals. It has also a corrosive action on the skin. The need for great care in its storage and use are therefore evident.

(*b*) The solution should not be made or kept in metal receptacles or containers. Such should be of earthenware or wood or glass and must be thoroughly cleaned out after use.

(*c*) It should be dissolved in hot water (the ounce of sublimate should be first dissolved and then the water brought up to eight gallons).

The use of corrosive sublimate in America has to a great

[1] Dr. K. M. Smith in *Annals of Applied Biology*, vol. xii, 1925, and vol. xiv, 1927.

[2] The Control of the Cabbage Root Fly. By Herbert W. Miles, M.Sc., Ph.D., in the *Journal of the Ministry of Agriculture*, vol. xxxvii, March 1931.

[3] Trials on the Control of certain Horticultural Pests in North Wales By W. Maldwyn Davies, Ph.D., B.Sc., in the *Welsh Journal of Agriculture*, vol. vii, 1931.

[4] Cabbage Root Fly and Methods for its Control. By E. E. Edwards, M.Sc., in the *Journal of the Ministry of Agriculture*, vol. xxxviii, March 1932.

extent replaced the old treatment there of protecting the plants by fitting round them, at the time of planting out, tarred felt discs. These discs fitting round the plant prevent the flies from laying their eggs close to the plant; eggs laid beyond the disc may hatch but the tiny larva fail to reach the plant. The disc must lie flat on the smoothed soil. In days past I have seen thousands of these discs in use in Canada and successfully. Experiments in England also gave good results but the method never became popular here. Experiments in England with naphthalene as a deterrent have yielded promising results. Cut stumps of infested plants and spoiled plants should be removed and destroyed to prevent the breeding out of large numbers of flies.

The Onion Fly (*Hylemyia antiqua*).—This fly belongs to the same Family (Anthomyidæ) as the last. The larva is a maggot resembling in general other Anthomyid larvæ and recalling in appearance the Cabbage Root Fly larva. Examination of the last joint of the body under magnification yields a good distinctive character; in the Onion Fly larva the fleshy projections round the hind margin are 14 in number and two pairs are larger as in the Cabbage maggot, but these large projections in the Onion Fly maggot are pointed at the tip and not forked.

While the onion is the common food plant, the maggots may also be found attacking leeks and shallots, and abroad garlic, all these plants being relatives belonging to the order Liliaceæ.

The first flies of the year appear in May from pupæ that have overwintered in the soil. These flies are not immediately able to proceed to egg-laying, but a certain amount of feeding must first be done. The ripe females lay their eggs in clusters on the plant. In the case of early attack on spring-sown onions the maggots when in numbers are extremely destructive, completely destroying the seedlings.

Invaded bulbs may harbour many larvæ (I have taken more than 20 larvæ from quite a small bulb) and in time the bulb is reduced to a rotting mass. Full-fed larvæ leave the attacked bulb and pupate in the neighbourhood of their place of feeding. There are two or more generations in the year with considerable overlapping, so that adult flies may be met with from May right on to the autumn. Signs of the presence of the larvæ are the yellowing and later a more complete bleaching and drooping of the leaves.

The Carrot Fly (*Psila rosæ*).—This is a tiny fly only one-fifth of an inch long and quite different in size and appearance from the last two named flies. In many parts of the country the Carrot Fly is the despair of the grower. Exigencies of space prevent more than the mention of the Carrot Fly, but in absence of longer notice readers of the JOURNAL are referred to a fine article, full of practical wisdom and good advice, on the fly and carrot growing by Mr. G. E. Greenhowe in the *Scottish Journal of Agriculture* for April 1930.

Elsewhere I have mentioned the possibilities of naphthalene

as a deterrent to flies, and I would like to draw the attention of our readers to what Mr. Greenhowe says of naphthalene and the Carrot Fly. "Not the least part of our method (i.e. Mr. Greenhowe's method) is the simplicity of the treatment, the procedure being as follows. When the carrot seedlings are well above ground, which may be towards the end of May or beginning of June, flake naphthalene should be sown broadcast over the carrot bed or plot at the rate of 1 oz. to 2 square yards, or say 1 lb. to 40 square yards, further applications being given at the same rate at 7-day intervals till the end of June, when three further applications might be given at 10-day intervals. We have confidence in our claim that the naphthalene treatment has been the means of removing all previous difficulties in the growing of carrots in gardens and on allotments."

I have records of attack on parsnip, parsley, celery. All four plants are members of the same order, Umbelliferæ.

FLAVOUR IN MILK—II.

Professor R. H. Leitch, M.A., B.Sc., N.D.A., N.D.D.,

The West of Scotland Agricultural College.

Relation of Pasture and Pasture Weeds to Flavour in Milk.—Normally the milk of cows at pasture, obtained under good hygienic conditions, has a sweet pleasant flavour. The so-called "grass flavour" sometimes referred to in dairy literature is usually caused by the contamination of the milk by the dung of pasture fed cows which are suffering from diarrhœa.

Certain pasture weeds if eaten by cows can cause very decided milk taints. The worst is garlic. The flavour of garlic may be detected in the milk of a cow within a few minutes of the consumption of the leaves of the garlic plant; in ten minutes the garlic flavour in the milk reaches a high degree of intensity. The odour of garlic is so strong that, even if the cow does not eat the plant but merely breathes the exhalations of the weed any time within an hour of milking, the milk will have a garlic taint. American investigators (11) have shown that the garlic odour may be detected in blood drawn from the jugular vein of a cow which has consumed the plant. This indicates that the garlic odour and flavour is absorbed by the blood stream, and in this way is transmitted to the milk gland.

Because of its well recognised effect on milk, garlic (*Allium sp.*) has been mostly eradicated from the pasture lands of Britain. It is still common, however, in other dairying countries. The garlic flavour is stronger in cream than in milk, and butter made from such cream is nearly always tainted, even when the cream is pasteurised. Siberian butter made in spring and some samples of Argentine butter are frequently reported

to have an objectionable smell and taste of garlic. When garlic tainted cream is heated in vacuo in a modified type of condenser called the deodoriser, the objectionable flavour disappears.

Garlic mustard and trench weed or penny cress (*Thlaspi arvenæ*) are two weeds which produce a garlic-like odour in milk. Eckles (12) has shown that the latter weed produces a well-defined taint even in the beef of cattle grazed on pastures containing it, and that in milk the taint is very persistent and survives in large measure the process of pasteurisation.

Bitter-weed (*Helenium tenuifolium*) when consumed induces a bitter taste in the milk. M'Donald and Glaesner (13), who found the bitter substance to be present both in the fresh and in the cured weed, were unable to remove it from the milk by any practicable means.

Chamomile present in seeds hay causes the cows consuming it to produce milk with an objectionable tarry flavour. Procter (14), who investigated the chamomile taint, found that not only the plant itself but also the addition of an extract of the weed to the food supply would produce the tarry flavour on every occasion on which it was tried. But because of the volatility of the taint-producing factor in the chamomile plant, the flavour is more likely to appear in the milk of early than of late winter.

The following pasture weeds are reputed to cause milk taints —shepherd's purse, wild lettuce, golden rod, mare's tail, foxglove, horseweed, water parsnip, fool's parsley, cowbane, yarrow, buttercups (*Ranunculus repens* and *R. sceleratus*), stinking mayweed, ragwort, tansy, and bog asphodel. The evidence for implicating each or all of these weeds is not very convincing.

Absorbed Flavours.—Milk on occasion may acquire a foreign odour and flavour from the environment. An unventilated or unclean byre is sometimes the cause. The effluvia of strong-smelling dung are often absorbed by newly drawn milk, and for this reason it is always advisable to remove the milk as soon as it is withdrawn from the cow to the purer air of the dairy, and not to allow it to remain for a time in a collecting vessel in the byre. Undesirable flavours in milk may sometimes be caused by the presence in the byre of a cow with suspended cleansings.

The odour of certain disinfectants used in paint work or in the whitewash for walls may, according to Danish observers, be readily taken up by milk. Carbolic acid is specially implicated. Dumbrowsky (15) found that the odours of iodoform, anise, turpentine and formaldehyde are readily absorbed by milk.

Cows under veterinary treatment often produce a tainted milk, the taint frequently arising from the administration of specific medicines, e.g. chlorodyne, iodine compounds, and aloes. The last-mentioned substance causes a bitter flavour, and results in a reduction of the fat content of the milk.

Flavour Defects of Bacterial Origin.—Bacteria which gain entrance to the milk after it has been withdrawn from the cow are a common cause of disagreeable flavours in milk.

The most frequent change which takes place in market milk on ageing is souring and the concomitant development of a somewhat bitter flavour. This dual change is due to the associative action of certain bacteria: the souring is caused by the lactic acid bacteria which are chiefly derived from the utensils, the bitterness is due to the action of proteolytic (mostly spore-bearing) bacteria which commonly originate from the cow's coat, from the milk vessels, or from the milking machine. The remedy here is plain: the preliminary cleaning of the cow's flank and udder, the rejection of the foremilk, the use of sterilized utensils, and milking with clean hands.

An abnormal aroma, resembling amyl alcohol, which renders milk unusable has been shown by Cunningham (16) to be caused by a specific germ (a micrococcus). The freshly infected milk shows no evidence of the taint, but within 24 hours it becomes pronounced. Prompt and effective cooling of the milk suppresses the development of the taint.

A disagreeable and unclean flavour in high grade milk which was originally believed to be a food flavour was shown by Sadler (17) to be caused by a variety of *B. ærogenes* derived from corn silage. This organism can cause pinholes in cheese and results in a bad flavour.

A member of the colon group of organisms, *B. lactis fœtidus*, produces in milk an unpleasant odour similar to the odour of turnips, and also a corresponding bitter repulsive taste.

A burnt or caramel flavour in milk caused by a variety of *Streptococcus lactis* has frequently been observed in market milk and in milk used for manufacturing purposes. The causal organisms are commonly derived from the utensils or from infected water.

A dough flavour may be caused by bacteria present in the milk before it leaves the udder. As Sadler points out (18), these bacteria (*Tetracoccus liquefaciens*) may also be derived from the fæces.

An offensive taste caused in milk by actinomycetes is recorded by Fellers (19). The off-flavour, which only develops after the milk is of some age (16 hours upwards), at first suggests a strong turnipy taint. Later the milk develops a bitter mouldy taste characteristic of actinomycetes. The infection was apparently derived from the bedding of the cows.

Orla Jensen (20) describes a putrid flavour in milk which is due to the action of certain bacteria which form hydrogen sulphide from sulphur. Milk which has passed through pipes made of vulcanised rubber (such as milking machine tubes) may on warming to a relatively high temperature acquire the smell of rotten eggs.

A flavour and smell associated with occasional samples of commercially sterilized milk and strongly suggestive of paracresol was found by Mattick (21) to be due to specific spore-forming organisms which survive the sterilization process and

are able to produce para-cresol or phenol by degradation of the tyrosine.

Metallic (or Oxidised) Flavours in Milk.—" Metallic " does not mean that the flavour so designated is directly due to the presence of a specific metal (or its salts) in solution in the milk; rather does it imply the gripping astringent taste which one commonly associates with the salts of certain metals, e.g. copper, zinc or iron. The objectionable flavour may or may not be due to the contact of the milk with metal equipment.

Under certain conditions the fat in milk may undergo degradation changes which profoundly affect the flavour of the milk. As a result of the alteration of the fat, the milk may acquire an astringent, cardboard or tallowy taste, the difference between these being one of degree only. These off-flavours are sometimes called " oxidised flavours " because they arise largely through the oxidation of the milk fat. Such oxidation is of a chemical nature and is a direct result of some of the dissolved oxygen in the milk itself being converted into an active state, in which condition it easily attacks the milk fat. This activation may be brought about or greatly accelerated by the exposure of milk to strong sunlight, or by the action of ultra-violet rays under certain conditions, but it is more commonly effected by the presence in the milk of small traces of certain metals, particularly copper. These agents act as catalysts, i.e. substances that help along chemical reactions without themselves being altered or undergoing change. Unlike the taints produced in milk by direct bacterial action, these oxidation effects may take place in milk of low bacterial count and in milk kept at low temperatures.

The effect of dissolved metals on the flavour of milk has received considerable attention. In 1905 Golding and Fielmann (22) found that the passing of milk over a partially detinned copper cooler resulted in a metallic flavour. Other investigators both in Europe and in America have attributed a metallic flavour to the presence in milk of metallic salts, which impart an astringent taste. As Seligman (23) indicates, however, it can only very rarely occur that the metals are dissolved in sufficient quantities to convey their own characteristics to milk. The harmful effects of certain metals which may be added to the milk through its contact with utensils and milk plant equipment are due mainly to their oxidative or catalytic action on the milk fat, resulting in flat, metallic and tallowy or cardboard flavours. On the farm tinned copper coolers, and in milk plants the milk pump, sanitary piping and internal tubular coolers (tin or copper) are the most frequent sources of danger (24). Copper alloys such as German silver, monel metal, benedict nickel, brass and bronze are all alike harmful to the flavour of milk. Burrell (25) found that a disagreeable barny or metallic flavour in the milk of a certified farm could be traced to the milking machine pail; the base of the pail was made of German silver, while the sides were con-

structed of tinned steel. When the German silver bottom was tinned, no further trouble was experienced. Rogers (26) reports that a cardboard flavour which developed in bottled pasteurised milk on being stored overnight was due to the passing of the pasteurised milk over a cooler the refrigerating section of which was made of German silver.

The corrosive effect of certain washing powders and chemical sterilizers on metallic dairy equipment has been determined by Hunziker (27) and the relationship to flavour defects in milk products pointed out. Tracy and Ruehe (28) found that the occasional occurrence in milk of a medicinal flavour was due to bringing milk into contact with tinned utensils and equipment treated with a chemical sterilizer a short time before using. If the tinned surface was allowed to dry before adding the milk or if the equipment was used immediately after treating with the chlorine compound the defect did not usually occur.

Milk or cream may acquire a definitely tallowy flavour if exposed sufficiently long to direct sunlight. Hammer and Cordes (29), who investigated this flavour defect, found that in some cases an exposure of 45 minutes induced tallowiness, and that a distinct off-flavour in certain milk samples developed after an exposure of only ten minutes. Frazier (30) showed that a " cardboard " taste and a " linseed oil " odour develop in whole milk which has been exposed to diffuse daylight for eight or more hours at about freezing temperature, the light apparently acting as a catalyst in the oxidation of the milk fat. He found also that the defect develops more rapidly in pasteurised than in raw milk, and that neither enzymes nor bacteria are necessary for the reaction.

Oily Flavour in Milk.—Milk with this taint has an odour resembling castor oil, and an obnoxious clinging and sickening taste. Oiliness occurs most frequently in the colder months of the year, and in Scotland has most frequently been experienced in the months of spring (January-March). Only on one occasion have we experienced it in summer milk. The oiliness is not obvious in the newly drawn milk; it most frequently appears in cold milk which has been stored for twelve hours or more. Bacteria do not seem to be directly responsible for the flavour defect, and it has not yet been demonstrated that any organism isolated from affected milk is capable of producing oiliness when introduced into normal milk. Nor can the effect be transferred by inoculating some oily milk into sterilised milk.

Mattick (31) has found that oiliness results from the catalytic action of minute traces of copper on the milk fat. The copper may be derived from the utensils. A frequent source is the milk cooler. When the tinning becomes worn locally, the copper sheath is exposed in small areas, and milk passing over the bare copper absorbs traces of the metal. Working under controlled conditions, Mattick found that normal milk passed over such a cooler, when kept for 16 hours at 50° F., developed a marked oily flavour; the control sample (not passed over this cooler)

remained unaffected. No obvious increase in bacterial numbers had taken place in the milk which became oily. The explanation of the oiliness would seem to be that the copper seizes on the oxygen and uses it to oxidise the fats of milk, which on oxidation give rise to the oily flavour, the low temperature restricting the growth and therefore the oxygen demand of the milk bacteria. In summer when the prevailing temperatures are higher, bacterial growth is rapid, and the milk organisms are able to use up the oxygen at a greater rate than the copper.

The experience of some who have investigated cases of pronounced oiliness in farm milk would appear to indicate that this defect may be due to other and more obscure causes. In several cases which have come under our observation, we have found that a definite oily taint may occur in milk which has not at any stage been in contact with metal equipment, and that it can often be traced to the milk of isolated cows in the herd. In the case of a south of Scotland dairy farm where a pronounced oiliness was experienced in the mixed milk of the herd, a specimen of each cow's milk was withdrawn directly from the udder into separate sterile glass bottles, cooled and held about 50° F. for 16 to 24 hours. Of the 32 cows in the herd, it was found that two cows were producing milk with the taint and that the others were normal.

What condition causes some cows to secrete milk which will develop an oily flavour has not yet been determined.

Relation of Pasteurisation to Flavour in Milk.—When milk is pasteurised by the flash method (160-165° F. momentarily) or "sterilized" commercially in bottles, it acquires a cooked flavour, due principally to the effect of the heat on the lactose. Milk pasteurised by the holding method has no appreciable cooked flavour, unless perchance the period of holding is prolonged beyond one hour.

Pasteurisation of the milk supply, especially when the mixed milk from many different sources is involved, undoubtedly improves the flavour of market milk. Freshly pasteurised milk has usually a sweet nut-like flavour; the odour of the milk is improved as well as the taste, the temperature to which the milk is heated being sufficient to disperse many volatile odours which detract from the flavour of the milk.

Some bacteria (32) which survive the pasteurisation process and even grow rapidly during the actual heat treatment (e.g. "thermophilic spore-forming bacteria") may cause a change in the reaction of the milk and affect its flavour prejudicially.

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An EXPERIMENT in the INTERPRETATION of FARM PROFITS.

E. WHITTAKER, B.Sc., N.D.A. (Hons.),

Advisory Officer in Agricultural Economics, Edinburgh and East of Scotland College of Agriculture.

THIS paper describes an experiment in statistical method, undertaken in an attempt to solve an important problem of economic advisory work.

Methods of Research into Farm Organisation and Management.—Farm organisation and management may be studied in several ways :—

(i) Farmers may be visited and plied with questions. This is generally known as the " Survey Method."

(ii) Information may be extracted from accurately-kept financial accounts. This procedure obviously involves more trouble, but gives greater accuracy than does the Survey Method. It is termed the "Financial Account Method."

In using either of these procedures in studying farm profits, figures are obtained bearing upon (*a*) the financial results of the farms concerned, and (*b*) the various factors considered likely to influence the results. Such factors may be : soil type, proportions of various products sold by the farms, intensity of production and the like. What influence these factors exercise upon profitableness has to be determined by some form of correlation analysis.

(iii) A third method, known as " Cost Accounting," seeks to split up the farm business into its component parts and determine the result of each component. For example, the business of a mixed farm may be divided into cattle feeding, sheep feeding, barley growing, &c., and the profit or loss made on each section determined separately. Thus, while the survey or financial accounting methods seek to determine the profitableness or otherwise of sheep in a system of mixed farming by noticing how the holdings with a large number of sheep fare in comparison with others, the cost

accounting method isolates the sheep enterprise within the farm and determines its results.

In practice a number, perhaps a considerable number, of farms are necessary if either of the first two methods is used, whereas, with the cost accounting method, results of value may be secured from accounts dealing with a single typical holding.

Choice of Method in the East of Scotland College Area.—Two practical considerations led the writer to use the financial accounting method, at least as a beginning.

(i) The ordinary farms of the area were large, and were rented at sums which, having regard to income tax provisions and the instability of profits, placed a heavy premium on account keeping. In consequence a large number of financial accounts, often professionally audited, was available for study.

(ii) The Department of Agriculture for Scotland had commenced, for statistical purposes, an investigation of farm financial records, although little progress had been made in the Edinburgh area. It was thought that the same financial account data, by duplicating the records, might be made to serve the purposes both of College research and of the Department's statistical investigation.

Selection of the Farms studied.—The farms selected for study were, as far as could be judged from preliminary enquiries, broadly typical of the more important agricultural systems in the district, particularly arable-sheep farming at low elevations in the counties of Berwick, Roxburgh and Selkirk, and arable farming for the production of sale crops in the Lothians and counties north of the Forth.

It was not possible to say in advance what size of groups of farms would be necessary for the success of the financial accounting method of research. In so far as it was desired to ascertain the causes of variations in the profits of different farms within the same general groups, the groups had to be large enough to enable the necessary correlation calculations to be made satisfactorily. If the profits proved to be governed by a large number of factors, each exercising but small individual influence, the groups would have to be very large. If, on the other hand, the profits were controlled to a large extent by a few factors only, each wielding considerable influence, much smaller groups would suffice.

It was not known beforehand which of these conditions would apply, and, if this were the only point to be considered, it would have been preferable to commence by studying a single group which included as many individual holdings as was practicable. The fact, however, that the two systems of agriculture already mentioned were both important in the area, and both in a precarious economic position, caused the farmers in the College area—wishing advice—and the Department of Agriculture for Scotland—requiring statistics—to desire some research at least on each of these farming types.

The research was, however, developed earlier, and has proceeded further, upon farms of the Border arable-sheep type than on the East of Scotland crop-selling farms. The statistical experiment described in the present paper deals, therefore, principally with the former type of agriculture.

Variations in Profits between Individual Farms of the same Type.—In all the sub-groups into which it proved necessary to divide the two general types of farms studied, there was found to be a very wide range in the financial results of the individual holdings. This fact is brought out by the following table, all the figures being arrived at on a strictly comparable basis :—

TABLE I.

Range of Results of Individual Farms, 1928-30.

Crop year 1928-29.

	Best result. £	*Worst result.* £
Sheep type of arable farm.		
(i) 13 low ground farms ...	+1,227	- 725
(ii) 3 higher land farms ...	+1,083	+ 569
Crop-selling type of arable farm.		
(iii) 5 suburban farms ...	+ 358	+ 40
(iv) 11 East Lothian rotation farms	+2,644	- 817
(v) 6 farms of the general East Lothian type but with greater emphasis on live stock	+1,223	-1,423

Crop year 1929-30.

	Best result. £	*Worst result.* £
Sheep type of arable farm.		
(i) 19 low ground farms ...	+1,331	- 297
(ii) 7 higher land farms ...	+1,415	+ 382
Crop-selling type of arable farm.		
(iii) 5 surburban farms ...	+ 657	- 17
(iv) 11 East Lothian rotation farms	+ 998	- 774
(v) 6 farms of the general East Lothian type but with greater emphasis on live stock	+ 298	-1,593

Since, with few exceptions, the farms represented business units of comparable scale, such a variation of profitableness of farms of similar types is, to say the least, remarkable.

Reasons for attempting an Analysis of Data from Smaller Groups of Farms than are generally considered necessary.—Farmers expect agricultural economists to be able to explain such

a state of affairs. The only way in which an explanation is possible from the study of ordinary financial accounts (as distinct from cost accounts) is by using some form of correlation analysis to ascertain what factors are associated with high and low levels of returns respectively. It was obvious that, if the number of such factors was at all large, the small groups of farms being dealt with did not provide promising material for analysis of this kind.

To have refused, however, to attempt an analysis of the data for this reason would have been to run away from a problem in whose solution the farmers were deeply interested. Further, it was not possible to say in advance of any trial whether or not any success might be achieved.

Difficulties in the way of Tracing the Causes of Variations in Profits.—Three difficulties arose at once :—

(*a*) It was not easy to choose the factors whose influence on profits was to be determined. These had to be chosen in advance so that farmers might be questioned on them.

(*b*) After the factors had been chosen, they were sometimes very difficult to measure. Thus, soil type and productivity were thought to be important factors. The difficulty of expressing soil type in the numerical way necessary for mathematical calculations is obvious. Similarly, a satisfactory measure of productivity was difficult to secure. The only one practicable under the circumstances proved to be a monetary one, i.e. money value of sales plus value of produce carried over at the end of the year, less money cost of purchases plus value brought over from the previous year. Such a measure obviously includes profit as well as production.

(*c*) Profits could be expected to be governed by more than one factor. Accordingly a simple correlation of any one factor (for example the proportion of land under arable cultivation) and profits, by observing how profits varied on farms with different proportions of arable land, might lead nowhere, because the profits might be as they were, not because of the proportion of arable land, but in spite of it, due to the operation of more important influences exercised by other factors.

Two Recognised Methods of correlating Farm Management Data.—Two methods of correlating farm management data are recognised.

(i) *The method of cross tabulation.*—This method has been used extensively in the United States of America. The procedure is to deal with each factor separately. Thus, the effect on profits of, say, the proportion of land under arable cultivation is examined by arranging the farms into small groups—running from those with most arable land to those with least—and noting the level of profits in each group. If, on balance, the farms with highest proportion of arable land show lowest profits it is concluded tentatively that arable cultivation is unprofitable.

The obvious defect of this method is that a relationship thus suggested neglects the effect of all factors other than the one

under examination. The profits noticed, in the instance mentioned, may be as they are in spite of the influence of the proportion of arable land, not because of it.

If a very large sample of farms is studied, and arable land has no connection with the other factors, the different groups of farms with varying proportions of arable land ought each to have an average amount of all other factors (i.e. an average amount of heavy soil, an average productivity, and so forth). In this event the influence of these factors "cancels out." Only if this is the case can it be assumed that any relation which may be suggested by the cross tabulation exists in fact.

(ii) *Mathematical method of multiple correlation analysis.*—This method seeks to determine, from a single calculation, the separate influence of each factor affecting profits. It is assumed that profits are as they are because of the influence of the given factors. The object of the calculation is to determine the direction and weight to be credited to each factor in order that the variation in profits actually observed may be most nearly accounted for.

As an experiment, both of these methods were tested upon data obtained in respect of the largest single group of farms studied for the crop years 1928-29 and 1929-30, i.e. 12 low ground arable sheep farms mainly situated in the counties of Berwick and Roxburgh in the former year, and 19 such farms in the latter year.

Factors considered to be connected with Profits.—After a number of trials, it was decided that the factors whose connection with profits was most marked were, in 1928-29 :—

(i) The money value of production.
(ii) The soil type.
(iii) The proportion of land under arable cultivation.
(iv) The relative proportions of cattle and sheep produced.

In respect of 1929-30 an additional factor was added :—

(v) The number of extra store lambs purchased, and the basis of calculating production was modified.[1]

Trial of Cross Tabulation Method.—The procedure adopted was to examine separately each of the factors thought to be connected with profitableness. The farms were grouped in threes, and the relation between the factor under consideration and profits examined. Thus, when the connection between the proportion of land under cultivation and profits was being investigated, the three farms with highest proportion of cultivated land were grouped together and their profits noted, similarly with the three farms whose proportion of cultivated land was next

[1] Instead of taking "gross production"—the total of the money value of the production (as defined on page 323) of each product—to represent productivity, "net production"—gross production less the cost of purchased feeding stuffs—was used. This modification was introduced to meet the circumstances that, as a result of low grain prices, some of the elements making up "gross production," particularly oats, had become interchangeable with purchased feeding stuffs.

highest, and so on until the group of farms with lowest proportion of such land. This method is exemplified by the following table, in which each set of figures represents the average for the three farms concerned.

TABLE II.

Table relating Production and Profits, 1928-29.

	Factor related.		Other factors.		
	Production per acre.	Profits per acre.	Percentage of land classed as heavy soil.	Percentage of area under crops other than grass.	Value of cattle production per £100 sheep.
					£
(i) 3 farms	£8 6 6	+£1 8 9	33·4	38·7	52 9
(ii) 3 ,,	7 7 11	+ 0 0 2	...	34·0	69·2
(iii) 3 ,,	6 17 4	+ 0 1 4	28·7	39·4	49·9
(iv) 3 ,,	5 16 8	– 0 18 5	68·7	34·9	35·5

At first sight the table suggests a close connection between production and profits, since profits fell fairly steadily as production decreased. However, as is shown by the columns headed "other factors," low production and low profits were associated with heavy soil, and, less definitely, with a low proportion of cattle. There is nothing in the table to show that profits were low only because of low production, since they might be low because the soil was heavy or because the proportion of cattle was small.

The corresponding tabulation for 1929-30 was, however, more informative. Thus :—

TABLE III.

Table relating Production and Profits, 1929-30.

	Factor related.		Other factors.			
	Production per acre.	Profits per acre.	Percentage of land classed as heavy soil.	Percentage of area under crops other than grass.	Value of cattle production per £100 sheep.	Number of extra store lambs purchased per 100 acres.
					£	
(i) 3 farms	£6 12 6	+£1 6 11	29·5	41·4	60·2	0
(ii) 3 ,,	5 19 11	+ 0 13 5	...	41·6	72·4	34·8
(iii) 3 ,,	5 13 10	+ 0 5 2	32·2	37·3	80·8	6·1
(iv) 3 ,,	5 6 9	+ 0 12 3	24·2	35·3	44·2	26·8
(v) 3 ,,	5 2 3	+ 0 4 6	..	34·5	84·9	28·3
(vi) 4 ,,	4 13 0	– 0 11 3	51·1	42·3	48·0	40·9

In 1929-30, contrary to what was noted in 1928-29, there seemed to be no connection between heavy soil and low production. As before, however, low production was accompanied by a low cattle proportion, and it was not possible to say from the

tabulation whether low profits were due to low production or to a low proportion of cattle.

Not all the tabulations, however, gave confused results. Two whose inference was comparatively clear are given :—

TABLE IV.

Table relating Soil Type and Profits, 1929-30.

	Factor related.	Profits per acre.	Other factors.			
	Soil type.		Production per acre.	Percentage of area under crops other than grass	Value of cattle production per £100 sheep.	Number of extra store lambs purchased per 100 acres.
					£	
(i) 5 farms	Heavy	+5*s.* 0*d*	£5 9 4	39 8	57 4	19 3
(ii) 14 ,,	Light and medium	+9*s.* 11*d.*	5 12 10	38 6	53 8	25 0

The four "other factors," i.e. production, the percentage of land under crops other than grass, the value of cattle production per £100 sheep, and the number of extra store lambs purchased, were spread as evenly over both "heavy" and "light and medium" soil as could be expected in groups of this size. Accordingly, it seemed fairly safe to conclude that heavy soil was rather less profitable in 1929-30 than was light and medium land.

TABLE V.

Table relating the proportion of Land under Tillage and Profits, 1929-30.

	Factor related.	Profits per acre.	Other factors.			
	Percentage of land under crops other than grass		Production per acre	Percentage of land classed as heavy soil	Value of cattle production per £100 sheep.	Number of extra store lambs purchased per 100 acres.
					£	
(i) 3 farms	51 8	+£0 6 0	£6 4 1		60 4	24 2
(ii) 3 ,,	47 6	− 0 2 1	5 4 10	44 4	49 4	13 6
(iii) 3 ,,	38 1	+ 0 19 3	5 16 4	35 3	66 1	22 6
(iv) 3 ,,	36 3	+ 0 8 11	5 11 11	29 4	44 7	36 0
(v) 3 ,,	33 6	+ 0 4 1	5 6 6	22 8	75 1	
(vi) 4 ,,	30 7	+ 0 14 3	5 11 4	17 7	42 9	30 4

In this table also the "other factors" were as evenly distributed over the several groups of farms having different proportions of arable land as could be expected with small samples, and it was reasonable to conclude that the relationship suggested by the table, i.e. that profits increased as the proportion of cultivated land diminished, was founded in fact.

It would be tedious to give, in detail, the tabulations referring

to all the factors which it was thought might influence profits. Perhaps the most interesting table was one comparing the farms which increased their profits in 1929-30 as compared with 1928-29 with those holdings whose profits diminished. The farms whose profits increased were largely composed of heavy land. In 1929-30 the heavy soil farms in general increased (*a*) their production, (*b*) their cattle proportion, and (*c*) their profits, owing, apparently, to seasonal conditions.

Only exceptionally, however, and that particularly in 1929-30 when the group included rather more farms, did the cross tabulation method give any very definite results.

Trial of Mathematical Method.—The method adopted, for simplicity and in view of the paucity of data, was that of calculating a "linear regression equation." The method seeks to arrive, by mathematical calculations from the data, at an equation from which—given the amounts for each farm of the various factors thought to influence profits (i.e. percentage of cultivated land, proportion of cattle to sheep, &c.)—the profits of the individual farms may be estimated. The general procedure described by Ezekiel [1] was adopted.

The result of the trial was to suggest with some definiteness the following conclusions :—

(i) In both 1928-29 and 1929-30 there was a strong connection between production and profits, farms whose production had a high money value tending to have high profits. This may not be unexpected, of course, since, as has been pointed out, the money value of production as calculated contains a profit element. None the less, if the relation were to persist it would be sound advice to the farmer to concentrate on obtaining a high money value of production (i.e. high "gross profits" in the terms of the farm accountant) rather than to "cut down costs."

(ii) In both years there was a negative correlation between the proportion of land under crops other than grass and profits, profits falling as the proportion of cultivated land increased.

(iii) In both years also a negative correlation between the proportion of cattle and profits existed, profits being lower on farms with a high proportion of cattle. This seemed more marked, however, in 1928-29 than in 1929-30.

(iv) In 1929-30, the only year in which this factor was brought into consideration, there was a negative correlation between the number of extra store lambs purchased for feeding and profits, farms buying in additional lambs showing smaller profits, and this, it may be remarked, in a year when sheep feeding was thought by farmers to be not unprofitable (in contrast with, for example, 1930-31, which was a notoriously unprofitable year in this respect).

The relationships suggested by the calculations were so

[1] M. J. B. Ezekiel: various publications, particularly "*Methods of Correlation Analysis*," 1930.

strongly marked as to be almost unbelievable; thus, for example, profits were calculated to fall by over £3 for every extra acre of land under crops other than grass. Such a position was possible only if the factors under consideration were, in effect, focal points of more important influences.

To test how far the formulæ obtained explained the profits of the individual farms, the profit for each farm in each of the two years was calculated and compared with that shown by the farmers' books. The results appear in the following tables :—

TABLE VI.

Comparison of actual Profits with those estimated by calculation.

	Estimated profit (+) *or loss* (−) *per* 100 *acres.*	*Actual profit* (+) *or loss* (−) *per* 100 *acres.*
Year 1928-29 (12 *farms*):—		
	+182	+166
	−216	−201
	52	87*
	−133	−144
	−164	−134
	80	65
	50	− 31
	− 39	− 44
	174	178
	64	− 40**
	31	125***
	97	171*
Year 1929-30 (19 *farms*):—		
	84	100
	− 2·5	6
	− 26	− 37
	79	99*
	63	36
	− 57	− 73
	20	24
	− 67	− 73
	84	151*
	37	82
	27	− 13**
	− 7·5	42***
	− 6	− 23
	− 61	− 42
	40	24
	98	45****
	142	78****
	165	175
	90	75

Both farms marked * were very well-managed. Their actual profits could be expected to be higher than those estimated.

The farm marked ** had a proportion of heavy land not allowed for. Its profits could be expected to be below the estimate.

Only part of the excess of actual profits over the estimate on the farm marked *** was explicable.

The two farms marked **** adjoined. In both cases actual profits were well below the estimates. Possibly seasonal causes were responsible.

The estimated profits were obtained, of course, from the formulæ resulting from the correlation calculations. The formulæ gave a basal profit (equal for all farms), to which was added so much for every £1 of production above the minimum, and from which was deducted the amount indicated by the formulæ for every extra acre of crops other than grass, for every extra unit of cattle as compared with sheep, for every extra store lamb bought for feeding purposes, and for heavy soil if this obtained.

One of the factors mentioned—the money value of production—itself included an element of profit. Thus, for example, the money value of cattle production included any increase in the per cwt. price of the fat cattle sold, as compared with the store cattle bought, as well as the value of the beef actually brought into existence on the farms. To this extent it could be expected that there would be some correlation between the money value of production and profits. A study of the relative levels of prices for the various products would forecast the direction, although not the extent, of the influence of other factors mentioned. Such a study would suggest that an increased proportion of grass as compared with arable land, of sheep as compared with cattle, and of store as compared with fat sheep, would be associated with increased profits.

The value of the figures obtained from the correlation analysis would seem to lie in (*a*) giving definiteness to ideas obtained from practical experience, or by *a priori* reasoning from price indices, regarding the relative profitableness of different products, and (*b*) providing figures (the "estimated profits") to serve as jumping-off points in studying matters concerning the internal management of the farms. For these reasons, what was admittedly an experiment has been thought worthy of description.

Auchincruive.

Notes from Agricultural Colleges.

Pig Feeding Experiment.—The pig feeding experiment under review was carried out in the new piggery at Auchincruive during the latter part of 1931. Previous experimental work had demonstrated that the inclusion of 10 per cent. white fish meal in the ration for pigs gave excellent results in live weight increase. In view of the relatively high cost of the white fish meal, a trial was conducted with an allowance of meat and bone meal in replacement of the white fish meal. Out of a number of pigs available for the experiment, 24 were selected and arranged in two groups of 12. The groups were made as uniform as possible, care being exercised that they were alike in regard to numbers from a litter, sex, age, weight, &c. At the final adjustment, the average age was slightly under 8 weeks old and the average weight was just over 31 lb.

A uniform basal ration consisting of maize meal, barley meal and thirds was fed to all the pigs.

The components in the meal mixture were varied throughout the feeding trial as undernoted :—

	First period of 6 weeks.	*Second period of 6 weeks.*	*Final period.*
Maize meal ...	2 parts.	3 parts.	4 parts.
Barley meal ...	3 parts.	3 parts.	3 parts.
Thirds ...	4 parts.	3 parts.	2 parts.

Fine thirds were used for the first period and common thirds for the second and final periods. The young pigs had thus the benefit of a larger proportion of fine thirds, whilst at the final fattening period the demand for a larger supply of carbohydrate was met by the increased proportion of maize meal.

In addition to the basal ration fed to all, the feeding for the two groups was :—

Group 1. Basal ration plus 10 per cent white fish meal.
Group 2. Basal ration plus 10 per cent. meat and bone meal.

The daily allowance of meal at the commencement of the experiment was 1½ lb. per pig, and in order to keep pace with live weight increase this was increased weekly by a quarter lb. per pig. Water was given throughout the feeding trial on the basis of half a gallon per lb. of meal fed. The mixed meals were fed raw and dry and the water given after the meal.

The pigs were weighed every fortnight during the experiment and the individual weights taken. The average live weight increase per pig for group No. 1 was slightly over 148 lbs., whilst the average live weight increase for group No. 2 was just under 138 lb. The average weekly increase for the two groups of pigs for the feeding period of 18 weeks works out as follows :—

Group 1. 8·22 lb. per pig per week.
Group 2. 7·65 lb. per pig per week.

It has already been noted that the commencing allowance of meal was 1½lb. per pig per day, and that a weekly increase per pig of a quarter lb. was given; the allowance in the eighteenth week was therefore 5¾ lb. The total quantity of meal consumed per pig was 456 lb., and this in the case of group No. 1 gives an increase of 1 lb. of live weight for every 3·19 lb. of meal consumed, while for group 2 3·3 lb. of meal were required to produce 1 lb. of live weight increase.

The total amount of fish meal consumed per pig in group 1 was 45½ lb., while in group 2 a similar amount of meat and bone meal was taken by each pig. At current prices of £17 per ton for fish meal and £11 per ton for meat and bone meal, the extra cost of the ration per pig for group 1 was 2*s*. 5*d*. The increased return in live weight of 10 lb. per pig, taken at three-fourths of the current rate of 56*s*. per cwt. for dead weight, gives a difference in favour of the fish meal group of 3*s*. 9*d*. per pig,

leaving a final balance of 1*s*. 4*d*. per pig in favour of white fish meal. It has also to be borne in mind that in order to increase the meat and bone meal group to the same live weight as the fish meal group attained at the end of the feeding trial, a further week's keep would be incurred, and this at the larger meal allowance of 6 lb. per pig per day or an extra 3 stone of meal, involving the expenditure of a further 3*s*. per pig.

The pigs at the end of the trial were sold on the dead weight basis to the Scottish Co-operative Wholesale Society, and were boned and rolled for the Ayrshire Roll trade. Cooking tests indicated that no adverse effects on the flavour of the bacon resulted from the inclusion of fish meal.

The conclusions can therefore be fairly drawn that :—

(1) Greater live weight increase at a lower cost can be obtained by the use of white fish meal than by the use of meat or bone meal.

(2) Pigs fed on a ration including a proportion of fish meal reach marketing stage fully a week earlier than those fed on a ration containing a similar proportion of meat and bone meal.

(3) So long as the proportion of white fish meal does not exceed 10 per cent. of the ration, the resulting bacon is unlikely to suffer from any adverse flavour.

Boghall.

Cattle.—This year a repeat experiment on the wintering of young stock is being carried out. The principle of this experiment is to test out the relative merits of inwintering against outwintering. The results up to the time of going to grass confirm last year's results in that when both groups receive the same amount of food the inwintered cattle make better live weight increases. Instead of putting the cattle which were inwintered straight out to grass this year, this process has been done gradually. The results obtained since then seem to justify this gradual acclimatisation to outside conditions.

Sheep.—It is known that nearly all classes of lowland sheep and especially lambs are prone to mild and acute infestations of parasitic worms, which generally lower the vitality and general health of the stock. An experiment has therefore been started on two groups of lambs, one of which receives treatment with a proprietary tablet at the rate of one per head per month, the other group receiving no treatment. All the lambs are weighed, and at the end of the season sufficient data should have been collected to give some information on this problem.

Pigs.—Pig-feeding experiments are being carried out, in conjunction with the other Scottish Colleges, to test some rations which have a special local significance, these rations being compared with an agreed standard ration. The basis of the local ration at present under investigation is surplus potatoes and potato brock. The scheme adopted is similar to the method

worked out in Germany by Professor Lehmann and consists of feeding 2¼ lb. per day of a meal mixture consisting of 7 parts barley meal, 1 part soya meal and 2 parts fish meal, the further requirements of the growing pig being met by the addition of boiled potatoes only. This results in an ever-widening protein and carbohydrate ratio. The results of these experiments will be published at an early date.

Ceresan Trials: Wheat.—A series of experimental plots of autumn sown wheat, some of which were treated with Ceresan, up till now has not shown any response to this treatment in respect of germination and tillering capacity.

Barley.—There would appear to be a slight benefit from dressing the seed with Ceresan. Some varieties, however, have responded better than others.

Oats.—There has been a definite response to Ceresan treated seed and plant counts have shown that 3¾ bushels of treated seed give rise to a field germination equivalent to that resulting from 5 bushels untreated seed.

Reviews.

Farm Tractors. Archie A. Stone. Chapman & Hall, 1932; pp. 492; price 23*s.*—Engineering is occupying an increasingly important place in agriculture and is a subject which the modern farmer cannot afford to ignore. Mr. Stone, who is head of the Department of Farm Mechanics, New York State Institute of Applied Agriculture, is obviously well qualified to write on that subject, and his present book deals with motor tractors in a comprehensive and lucid manner. The book, which is intended for students as well as tractor owners and operators, probably goes beyond the needs of the ordinary farmer, but it contains a great deal of useful practical information which cannot fail to be of value to anyone with tractors under his care.

Beginning with a brief survey of the development of the farm tractor, a description is given of the various stages of manufacture in a modern factory. This is followed by a detailed and particularly clear description of the construction and working principles of the engine, magneto, carburettor and other parts of the machine. Part II deals with the actual running of the tractor, and a study of this section of the book, read in conjunction with the book of instructions issued by the manufacturer, should enable any tractor operator to get the best out of his machine. Useful information is given regarding the choice of tractor to suit different conditions and of implements designed to secure efficient loading. A chapter is also devoted to belt work. The last part of this book gives fully detailed instructions for carrying out all kinds of repairs. Much of this will be found of practical value, but the ordinary farmer will no doubt be content to leave

the bigger repairs to the expert and would be well advised to do so.

The letterpress and illustrations throughout refer to American machines, but as the underlying principles of construction and operation are applicable to all types of tractors driven by paraffin or petrol engines, this need not detract from the value of the book to British farmers.

A Study of Empire Wool Production. J. E. Nichols. 148 pp. Wool Industries Research Association, Leeds. 5*s.* net.—From 1928 to 1931 Dr. Nichols, who is on the staff of the Wool Industries Research Association, carried out a survey of most of the principal wool producing areas of the Empire outside Great Britain. The expenses of the tour were defrayed by means of a special grant from the Empire Marketing Board.

The results of the survey are contained in this book. Detailed information about sheep and wool is given separately in respect of each of the countries visited—Australia, New Zealand, South Africa, Canada, Southern Rhodesia, Kenya, Palestine, and the Irish Free State. In addition general questions affecting wool production and wool improvement are discussed.

The information given for the individual countries is comprehensive and valuable, covering such factors as natural conditions, types and breeds of sheep and their distribution, classes and characteristics of wool produced, the preparation and marketing of wool, and the extent of manufacturing and allied industries associated with sheep breeding and wool production. A careful analysis is made of the causes affecting present conditions and tendencies, and this adds greatly to the value of the survey, particularly in view of the wide diversity of conditions existing in the different parts of the Empire visited. The book would, however, have been improved by the inclusion of information on similar lines in respect of Great Britain; but the author cannot be held responsible for this omission.

The remaining sections of the report contain a careful examination of the general considerations affecting the production of wool and the problem of wool improvement. The author's practical outlook may be gathered from the following quotation :—

> "Any means of wool 'improvement' which serves only to remove a particular type of wool from one specific manufacturing class to another is of little real benefit, if any, and if it involves changes in mutton or breed characters such as hardiness it would not usually be adopted in practice. For instance, wools of carpet type, such as the Scotch Blackface, may be displaced from this particular class by cross-breeding, e.g. with Merinos, and be called upon to enter into competition with others much more suitable for other purposes, while, at the same time, the value of the sheep for slaughter may be lessened."

The book is illustrated by 25 plates, some of which are

excellent, others not so good. In addition there are a number of statistical tables and three graphs. The latter do not add greatly to the value of the book.

Pistol v. *Poleaxe*. Lettice Macnaghten. Chapman & Hall.—This is a weighty and voluminous plea for the use of humane methods in the slaughter of animals for human food. The material has obviously been carefully and laboriously collected by the author, who quotes numerous official reports and private opinions, and who has visited and inspected slaughterhouses in all parts of Britain and Ireland. One cannot but be impressed with the thoroughness of the presentation of her case and her fair and judicial treatment of the opinions of those who are opposed to innovations which she advocates.

It is gratifying to note that Scotland has led the way in adopting these newer methods, and that since 1st January 1929 it has been illegal to use the poleaxe for slaughtering cattle, the use of mechanical humane killers having then been made compulsory. So far as Scotland is concerned, therefore, Miss Macnaghten is preaching to the converted. At the same time there are here and there slaughterhouses where the general conditions and methods are not beyond reproach, although in this matter also there has been great improvement, and in these cases the plea put forward in this book for consideration of the feelings of the animals about to be killed should not fall on deaf ears.

Lord Lee introduces the book with a highly commendatory preface, and Professor Linton, who has a wide experience of abattoirs, expresses the sympathy of the veterinary profession with the humane practices advocated.

Fertilizers and Food Production on Arable and Grass Land. Sir Frederick Keeble, C.B.E., Sc.D., F.R.S. Oxford University Press.—The purpose of this publication is to show that an increase in the use of artificial fertilizers by British farmers would be followed by an immediate increase in the production of foodstuffs both on arable land and on pasture. Estimates, based upon experimental results, are made of the increases attainable by this means, and the conclusion is reached that, whereas at present home production of foodstuffs in Britain is rather less than two-fifths of the total quantity consumed, this output could be raised in the near future to more than one-half, and within ten years or so the country might become all but self supporting in milk, meat, and the other animal products of the farm. In the case of Ireland, indeed, the writer becomes quite poetically prophetic, averring that the result of the application of the new methods would be "as though by some magical enchantment the grazing area widens and widens until it becomes double, and time for ever indissolubly linked with it narrows as space widens, until the future shines on the horizon of the present, glowing in the mellow light of prosperity and contentment."

If this happy state can be attained at the cost of a few

shillings per acre per annum spent upon sulphate of ammonia and phosphates and potash—applied according to the precepts herein set forth, the problem of our depressed agriculture appears to be at least half solved. Individual initiative and skill in management, accompanied by political action directed to securing remunerative prices for the produce, it is pointed out, are however likewise needed for complete rehabilitation of British agriculture.

The results of experimental work at the Jealott's Hill Farm of Imperial Chemical Industries and on numerous farms in Great Britain and Ireland are used to indicate the beneficent effects of the judicious application of artificial manures both to arable land and to grass. In connection with management of grass land a full account is given of the rotational method of manuring and grazing of which so much has been heard in recent years. Taking the increases made possible by the more generous use of artificial fertilisers on arable and grass land together, the writer estimates the return to the nation as a saving of somewhere near 100 million pounds annually on the charges for imported foods.

The book is well produced, the arguments are in the main clearly and simply put in direct and forceful style, and the charts with which the letterpress is illustrated are plain and striking.

Sir Harry M'Gowan, Chairman of Imperial Chemical Industries, contributes an introduction.

Growth and the Development of Mutton Qualities in the Sheep. John Hammond, M.A., and A. B. Appleton, M.A., M.B. Oliver & Boyd, Edinburgh.—To the series of biological monographs and manuals edited by Dr. Crew and Mr. Ward Cutler this survey of the problems involved in meat production has been contributed by Mr. Hammond of the Institute of Animal Nutrition, Cambridge, who in one section of the work has had the assistance of Mr. A. B. Appleton, Lecturer in Anatomy in Cambridge University.

As stated in the general introduction, the object of the investigation was to make a general survey of the scientific principles involved in the production of meat from the physiological, anatomical and practical points of view. The problem has been approached from the starting place of the end product—the meat itself—and from that, working backwards, an effort has been made to find out the factors affecting its formation. The basis of investigation taken is weight, and along with that an attempt is made to identify the factors that make for quality and to determine whether they are physiologically incompatible with large size. The meaning and application of early maturity are considered and its effect studied on the lowering of cost of production of meat in recent years.

The investigation involved first the study of the factors which influence the rate of growth in live weight of the individuals in a flock, and second the determination of the composition of the

growth made at different periods in terms of body organs and tissues and the factors which influence this; the first being more directly the farmer's, and the second the butcher's point of view. The further problem is also faced—how far the characters involved are genetic and how far they are dependent on environmental conditions. When the direction and extent of variability in weight and composition due to environmental conditions are known, then the true genetic value of any animal may be better gauged.

The treatment of the subject is highly technical, and it will probably be sufficient here merely to mention the sections of the subject dealt with, viz. :—the rate of growth in live weight in a flock of Suffolk sheep; the carcase percentage and the relevant development of the different organs in the body; variations in the rate of development of different parts of the skeleton; variations in the proportions of muscle, fat and bone in the carcase.

Part V gives a full account of an intensive histological and chemical study of the leg of mutton as representing the variations in the composition and proportions that occur in the carcase as a whole. Age-changes, the effects of sex and of castration, and the effects of fattening, as they affect the structure of the limb, are dealt with, and the relative mass and distribution of muscle, bone and fat are investigated. An interesting section treats of the factors affecting the edibility of the meat, its tenderness and flavour.

The illustrations are numerous and well reproduced, and a full account of them is prefixed to the text.

The work in itself and its presentation make an admirable example of what such a monograph should be.

THE following letter contributed by Sir A. D. Hall appeared in *Nature*, No. 3265, vol. 129, and is reproduced by kind permission of the Editor.

Senile Degeneration in Plants.

The question of the "wearing out" of varieties of cultivated plants that are propagated asexually is a subject of recurring discussion, one of the latest contributions being a paper by Bijhouwer.[1]

The classical example is that afforded by the continual replacement of varieties of potatoes by newer varieties, which in their turn seem to lose vigour and disappear from cultivation. But this may be explicable by the tendency of potato stocks to accumulate "virus" diseases, which will eventually reduce the cropping power of the variety by one-half. Again, the Ribston Pippin apple is often quoted as a variety that has become so liable to canker that it can only profitably be grown on the most favoured soils. But there is evidence that from the time of its general distribution, about a hundred and

[1] Abbreviated version, *J. Pomology*, 9, 122 (1931).

fifty years ago, Ribston Pippin has been a bad "doer," retained on account of the outstanding quality of its fruit. So the argument runs on; one school maintaining that varieties not regenerated from seed grow old, while the other argues that the evidence points either to the accumulation of disease or to practical displacement by the introduction of improved varieties. The purpose of this note is merely to direct attention to a most remarkable example, which seems to have escaped notice, of age in a clone only propagated vegetatively.

The saffron crocus (*Crocus sativus* Linn.) has been cultivated on a large scale for a very long time. It is still grown in Spain, Italy and the Mediterranean countries to yield commercial saffron (the dried stigmas of the flower). It was grown as a crop in the sixteenth and seventeenth centuries between Saffron Walden and Cambridge (*vide* a paper presented by the Hon. Charles Howard to the Royal Society in 1678).[1] Yet the saffron crocus of cultivation is a sterile clone, increasing only by the numerous small offset corms it produces. No wild habitat is known, and though there are several closely related forms from Greece and the Levant which are fertile, none is identical with the true saffron crocus. Its sterility is reported by all the old writers and is now explicable by its irregular chromosome constitution. But the exceptional feature is the antiquity of the records we possess of the saffron crocus. Not only was saffron as dye and drug familiar to the Greeks, but also in the Temple of Minos, in Crete, Sir Arthur Evans disclosed a beautiful fresco representing a man gathering saffron, the identity of the flowers being unmistakable because of the highly coloured protruding stigmas. The fresco is reproduced in colours in Sir Arthur Evan's "The Temple of Minos," vol. 1, p. 265. The fresco belongs to the Middle Minoan period, *c.* 1900-1800 B.C., thus giving a recorded history for this clone of more than 3700 years.

Improvement of Live Stock (Licensing of Bulls) Act, 1931.

THE aims and chief features of the measure were briefly referred to in the issue of this JOURNAL for October 1931. Since then, the Secretary of State, by Order dated 9th March 1932, has fixed the first day of August 1932 as the date upon which the Act shall come into operation in Scotland. Further, Regulations dated 16th April 1932 (S.R. & O. 1932, No. $\frac{258}{S\ 15}$) have now been made by the Department in accordance with the requirements of the Act. In adjusting these Regulations, the Department have acted in agreement with an Advisory Committee composed of representatives of the Agricultural Associations and Breed Societies. The advice and assistance of this Committee have been of great value.

After 30th September next any person who owns or has in his possession or custody a bull of the prescribed age must be in

[1] *Phil. Trans.*, *12*, 945 (1678).

possession of either a licence or a permit in respect of the animal.

A licence enables an owner to keep the bull in question for the service of cows. A permit enables an owner to keep the bull in question during a specified period, e.g. for fattening, but not for purposes of service.

It should be noted, however, that bulls born on or before 1st August 1931 are exempt from the provisions of the Act, and accordingly no licence or permit is required in their case.

The prescribed age has been defined as follows :—

Bulls born in December in any year will be of the prescribed age on the 31st March in the second year thereafter, e.g. a bull calved in December 1931 will be of the prescribed age on 31st March 1933.

Bulls born in the months of January, February, March, April, May and June in any year will be of the prescribed age on 31st March of the following year, e.g. a bull calved in April 1932 will be of the prescribed age on 31st March 1933.

Bulls born in July, August, September, October and November in any year will be of the prescribed age on 30th September in the following year, e.g. a bull calved in November 1931 will be of the prescribed age on 30th September 1932.

Application for licences must be lodged with the Department on the prescribed form (obtainable from the Department) :—

(a) For bulls born in December—not later than 31st December of the next year.

(b) For bulls born in January, February, March, April, May and June—not later than 31st December of the same year.

(c) For bulls born in July, August, September, October and November—not later than 31st July of the next year.

The Department have published a short "Guide" to the Act which should prove useful to farmers and others concerned in the keeping of bulls. Copies of the Guide may be obtained free on application being made to the Secretary, Department of Agriculture for Scotland, Queen Street, Edinburgh.

"White Tip" Disease of Leeks.

THE Plant Pathology Department of the Department of Agriculture, with the assistance of certain commercial firms, has conducted investigations into the causes and possible methods of treatment of this disease, and the results obtained are summarised in the following note.

1. The causal fungus produces its summer spores on the surface of the soil abundantly under moist conditions and these

are blown on to the leaves of leeks, whence infection commences. These summer spores are also formed on rotting wet leaves, whence they may be disseminated to healthy leaves, starting a new centre of infection. Usually, in the Lothians, spread is slow, chiefly owing to the fact that weather conditions are rarely conducive to epidemic spread.

2. The fungus has been proved to be able to live saprophytically in the soil, and therefore the absence of leeks is no bar to the survival of the parasite.

3. Wild plants, cultivated onions and chives have not been found infected by this disease.

4. The practice of ploughing in diseased leeks is to be deprecated, as the parasitic fungus is merely returned to the soil, possibly in a more vigorous condition, and proves of danger to succeeding crops.

5. Experiments to control the disease have been continued and the following treatments have been applied :—

A. Bordeaux mixture.
B. Ammonium polysulphide.
C. Copper lime dust.
D. "Bouisol."

The conclusions from the past season's trial were that there was so little difference between the treated sets and the control plots that nothing could be recommended. The ammonium polysulphide gave slightly better results than the other treatments, but even this could not be recommended. Owing to pressure of work and unfavourable weather conditions, these plots could not be started until 22nd December 1931, and it is thought that the original time suggested, viz. October, would have been better. It has been suggested that these trials should be repeated, commencing in August or early September and repeating in November next.

In 1928-29 a set of control experiments was conducted, viz :—

A. Bordeaux.
B. Burgundy.
C. Ammonium polysulphide.

These were applied and ammonium polysulphide gave the best results of the three treatments, although proper control was not obtained. The conditions were different from those under which the later set of experiments was conducted, although again the treatments were applied after the plants had become infected.

The glasshouse observations at the laboratory and a study of temperature relations of the fungus brought out the fact that infection commences in September and possibly also in August to a small extent. This means that spraying should commence in August or early September at the latest.

6. A set of varieties and strains was tested last season for resistance but none proved of use in this capacity. Six sets of strains have been started this year, and it is hoped that later in the season many more will be started. Glasshouse accommodation is kindly being provided by the Seed Testing Station when the glasshouses are empty after the virus disease tests for this season are finished.

A rather full description of this disease and the parasitic fungus was published in the *Transactions of the Botanical Society of Edinburgh*, Vol. 30, Part IV, 257-281, 1931.

Farm Wages in Scotland.

As before, the Department issued with their Monthly Agricultural Reports for 1st January and 1st July supplements giving the wages of various classes of workers at the Martinmas and Whitsunday terms. This article summarises those statements and gives a comparison with the wages current at Whitsunday 1931; similar articles appeared in the July issues of the JOURNAL for the last three years.

The pecuniary values of the allowances given in addition to cash wages, as reckoned at each of the last three terms, are as follows :—

	Whitsunday, 1931.	Martinmas, 1931.	Whitsunday, 1932.
Meal, per cwt.	13*s*. 6*d*.	16*s*.	17*s*.
Milk, per gallon	1*s*.	1*s*.	1*s*.
Potatoes, per ton	£5	£5, 10*s*.	£6, 10*s*.
Coal, per ton	£1, 15*s*.	£1, 15*s*.	£1, 15*s*.
House, per annum	£6	£6	£6
Board and lodging for single men, per week	14*s*.	14*s*.	14*s*.
Bothy accommodation, with attendance, per annum	£9	£9	£9
Bothy accommodation, without attendance, per annum	£6	£6	£6
Keep of cows and followers, per cow, per annum	£10	£10	£10

The only items the estimated values of which show changes during this period are oatmeal and potatoes. The increase during the year in the value of a hundredweight of meal would mean, for men who receive 65 stone per annum, about 6½*d*. per week, while that in the value of potatoes would mean, for men getting a ton a year, about 7*d*. per week.

The arithmetical averages of the Department's figures for the wages of married men are as follows :—

Average Weekly Earnings of Married Men.

	Summer, 1931.						Winter, 1931–32.						Summer, 1932.					
	Cash.		Allowances.		Total.		Cash.		Allowances.		Total.		Cash.		Allowances.		Total.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Ploughmen ...	28	3	8	3	36	6	28	3	8	8	36	11	27	11	9	1	37	0
Cattlemen ...	29	8	8	7	38	3	29	1	9	2	38	3	28	8	9	6	38	2
Shepherds ...	28	3	10	3	38	6	28	6	10	7	39	1	28	0	11	0	39	0

The total earnings in each case show little change as compared with those of last year, the cash wages being less by from 3*d.* to 1*s.* per week, while the values of the allowances are greater by from 9*d.* to 11*d.*

Married Ploughmen.—The following table gives in round figures the weekly earnings of married ploughmen in summer 1931 and in summer 1932 in respect of 38 out of the total number of 50 counties and parts of counties included in the Department's wages statement :—

County or District.	Summer, 1931.			Summer, 1932.		
	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.
					s.	*s.*
Wigtown ...	24	15	39	24	16	40
Kirkcudbright ...	31	4½	35½	30	5	35
Dumfries ...	34	3½	37½	32½	4	36½
Selkirk ...	32	6	38	31	7½	38½
Roxburgh ...	32	6	38	31	7½	38½
Berwick ...	32	6	38	30	7½	37½
Peebles ...	33	4	37	33	4	37
East Lothian ...	33	4	37	33	4	37
Midlothian ...	33	4	37	33	4	37
West Lothian ...	33	4	37	33	4	37
Stirling ...	38	6½	41½	38	6½	44½
Dunbarton } Lower Clyde Valley	37	3	40	37	3½	40½
Lanark (N.W.) } Lower Clyde Valley	36	4	40	36	4½	40½
Renfrew } Lower Clyde Valley	34	4	38	34	4	38
Ayr (N.) ...	34	9½	43½	34	10	44
Ayr (S.) ...	33½	4	37½	34½	4½	39
Lanark (S.E.) ...	34	4	38	34	4½	38½
Clackmannan ...	36	3½	39½	34	4	38
Fife (S.W.) ...	36	3½	39½	34	4	38
Fife (N.E.) ...	25	12	37	25	13½	38½
Kinross ...	28	11	39	26	12	38
Perth (S.E.) ...	27	13	40	27	11½	38½
Perth (Central) ...	27½	10	37½	27	11	38
Angus (S.W.) ...	27	10	37	27	11	38
Angus (N.E.) ...	24½	11½	36	26	3	39
Kincardine ...	24	11	35	26	12	38
Aberdeen (E.) ...	22½	10½	33	21½	11½	33
Aberdeen (N.E.) ...	22½	11	33½	21½	12	33½
Aberdeen (Central) ...	20	10½	30½	22½	11½	34
Aberdeen (S.W.) ...	22½	9	31½	22	11	33
Aberdeen (N.W.) ...	21	10	31	20½	11	31½
Banff (N.E.) ...	21½	9½	31	20½	11	31½
Moray ...	24	10½	34½	24	11	35
Nairn ...	23	12	35	21	13	34
Inverness (E.) ...	23	12	35	21	13	34
Ross and Cromarty (E.) ...	22	12½	34½	21	3½	34½
Sutherland ...	18½	13½	32	18½	14½	33
Caithness ...	16½	15	31½	16½	17	33½
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Average ...	28 3	8 3	36 6	28 0	9 0	37 0

The arithmetical average of the cash wages for these 38 areas is lower than last year by 3*d*., while the value placed on the allowances is higher by 9*d*.

Seventeen of the districts show a slight reduction in the cash wage but four others show small increases.

The range of the total wages, including cash and allowances, in the various divisions of the country is as follows :—in the southern counties from 35*s*. to 44*s*. 2*d*.; in the south-eastern counties from 37*s*. to 38*s*. 4*d*.; in the Lower Clyde Valley from 38*s*. 1*d*. to 40*s*. 6*d*.; in the remainder of the central area from 35*s*. 8*d*. to 47*s*. 3*d*.; and in the north-eastern and northern counties from 29*s*. 11*d*. to 38*s*. 1*d*.

Single Ploughmen.—The average wage of single ploughmen in the south-eastern counties is 33*s*. 5*d*., or 5*d*. less than last year. In the south-western districts wages vary from 25*s*. 6*d*. in South Ayr to 31*s*. in South-East Lanark. In the Lower Clyde Valley and North Ayr the cash wage averages 16*s*. 8*d*., as compared with 17*s*. 3*d*. a year ago, with board and lodging valued at 14*s*. The average cash wage in the east-central division is 23*s*. 2*d*., or 1*s*. 6*d*. less than last year, while the allowances, valued at 6*s*. 7*d*., show an increase of 4*d*. In the northern and north-eastern counties the average cash wage is 18*s*. 9*d*. and the value of the perquisites is 11*s*. 10*d*. In Scotland as a whole a single ploughman's wage is 30*s*. 7*d*. (cash 20*s*. 5*d*. and allowances 10*s*. 2*d*.).

Women Workers.—Female dairy workers generally receive board and lodging, which have been valued at 14*s*. per week, and cash wages ranging from 9*s*. 3*d*. in Orkney to 18*s*. 6*d*. in South-West Aberdeen and Central Argyll. In the Lothians and Peebles a cash wage of from 23*s*. to 24*s*. is paid, with no allowances. Other women's rates, including board and lodging or their equivalent, vary between about 22*s*. 6*d*. in Orkney and 29*s*. 5*d*. in South-West Aberdeen. Where the whole is paid in cash the wages run from 18*s*. to 23*s*. per week. Women paid by the day generally receive from 3*s*. to 4*s*.; in Wigtown, however, the wages paid range from 2*s*. to 3*s*. 6*d*., in Skye from 2*s*. 6*d*. to 3*s*., in South-East Perth from 2*s*. 6*d*. to 3*s*. 6*d*., in Stirling from 3*s*. to 5*s*., and in North-East Angus 4*s*. 6*d*. Women paid by the hour generally receive from 4*d*. to 6*d*.

Boys.—In most districts boys engaged for a six months' period receive cash wages as well as board and lodging. The cash wages paid vary according to ability and experience. Where both are given the estimated total wage ranges from 20*s*. 2*d*. to 27*s*. 1*d*. In a few districts where cash wages only are paid the rate varies from 14*s*. to 21*s*.

Girls.—In the Lothians and Peebles girls generally receive about 14*s*., and in Roxburgh and Selkirk about 15*s*. per week, with no allowances. Where board and lodging are provided the estimated total earnings vary from about 20*s*. 11*d*. to 25*s*. 11*d*.

Casual Workers.—Men are generally paid from 4*s*. to 6*s*. per day and in some cases down to 3*s*. and up to 8*s*.; the weekly rate varies from 30*s*. to 40*s*. Women are usually paid from 3*s*. to 4*s*. per day, or 5*d*. to 9*d*. per hour.

Agricultural Conditions.

EXCEPT for a few night frosts in eastern districts at the beginning of the month, the weather during March was open and generally rather mild. The first three weeks were fine and dry, and farming operations proceeded in a very satisfactory manner, but during the last week or ten days of the month and throughout the whole of April unsettled conditions prevailed in all parts of the country. In the north and north-east showers of rain, hail or snow were frequent throughout April, but in the west several fine intervals occurred during the latter half of the month; in the south the weather was cold and broken but bright and sunny periods were more general. The germination and the growth of crops, the progress of live stock and the outdoor work on farms suffered more or less severely from the harsh and wet conditions experienced during this period. Cold and wet weather continued during the first two or three weeks of May, but during the last week or ten days it was generally drier and milder, and both crops and live stock responded well to the more genial conditions.

The development of the young wheat plants was slightly checked by frosts at the beginning of March, and as a consequence of the cold and unsettled conditions during April growth was rather slow. During May, however, the crop improved very considerably in appearance. Estimates of the area under the crop indicate that the acreage sown this year will show an increase of approximately 2,500 acres as compared with last year.

The break in the weather during March occurred just as farmers were about to begin the sowing of barley. When the work began, however, it proceeded fairly quickly, and in many parts of the country seeding was practically completed by the end of April. In most cases the land was in good condition with a fine tilth for the reception of the seed and sowing was carried out under very fair conditions. At the beginning of June early-sown barley had a fairly strong and well-planted appearance. The reports received from later districts were not unfavourable generally, but in some cases the braird was said to be rather backward or lacking in colour. According to the estimates furnished by the Department's Reporters, the acreage sown has been very substantially reduced as compared with last year.

The seeding of oats began earlier than usual and in most districts a particularly good seed-bed was obtained. Later on, however, some of the land sown in February had to be resown.

The crop did not grow at all rapidly, but at the end of May the plants were said to be fairly thick on the ground and had a healthy colour generally. On wet land and where the crop was sown earlier than usual the plants had a less satisfactory appearance. Minor attacks of grub were reported from Dumfries and Kincardine. In several of the principal arable counties the area under the crop this year is estimated to show increases of about 5 or 10 per cent., while in a few other districts the estimated increase varies between 15 and 25 per cent.

At the beginning of June beans had a healthy and vigorous appearance generally. In Kincardine at that time the crop had not yet brairded. During the winter months rye-grass and clover seeds became well established and showed exceptionally thick and strong growth. The cold weather of the spring, however, checked the vitality of the young plants, and at the end of April the development of the crop was little if any above the average for the time of the year. A month later, however, reports indicated that the plants showed promise of a bulky hay crop.

Potato-planting began much earlier than usual. The soil was in a satisfactory condition for the work and at first it seemed probable that planting would be accomplished more expeditiously than usual. To some extent, however, the work was delayed by the unsettled weather. At the end of May early varieties had not made very good progress, and it was reported that on some farms where the seed had been planted exceptionally early the haulms then showed only average growth, while second earlies were only just showing above the ground in south-western districts. From the estimates of acreage furnished it appears that the total area under potatoes will prove to be somewhat greater than last year. The preparation of the ground for root crops was hampered by rain. In some eastern districts sowing was held up for a few days at a time by the sodden condition of the soil and eventually was carried out on rather a rough surface. In the west and south-west and on many farms in the Lothians and North-East Fife the sowing of turnips and swedes had been practically completed in fair order before the end of May, but generally the work was in arrear and in several northern and eastern areas little more than a beginning had been made. In Ayr and Wigtown, however, at the beginning of June the crop was ready for singling. Sugar beet was then just coming through the ground. The total area under this crop will, it is thought, show little or no increase as compared with last year.

Fruit-trees made a good show of blossom in those districts where they are most widely grown and the prospects are fully up to the average. A little damage was caused by late frosts. Small fruits promise well.

Pastures were not so fresh and green at the end of April as they were at the beginning of that month. During the first half of May cold winds checked the growth of grass, but towards the end of that month grasslands recovered rapidly with the advent of milder weather, and grazing cattle made good progress.

Ewes were in better condition at lambing time than they have been for several years. The cold winds and the check they gave to the pastures affected both ewes and lambs but not to an abnormal degree and, despite the rather unsatisfactory weather, the ewes had sufficient milk and the lambs made good average progress. On low-ground farms the crop of lambs was a good average, but on the hills the results were not quite so good generally. The lambs are reported to be fairly sturdy and thriving well.

At the beginning of June the supply of regular and casual workers was adequate. Indeed, it seemed probable that in some parishes of Aberdeen, Angus, Banff, Inverness, Kincardine, Kirkcudbright, Perth and Wigtown a number of farm workers would find difficulty in securing engagements.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Types of Rape used in New Zealand: Preliminary Investigation Work. *J. W. Hadfield, Agronomist, Plant Research Station, Palmerston North, N.Z. Journal of Agriculture, Volume* 43, *No.* 4, 20*th October* 1931.—The author summarises the results of his investigations as follows:—

"The trials indicate that there are at least three types of rape grown in New Zealand. Type 1 is a large-leaved Giant rape giving a greater initial bulk of feed than the other types, but not the recovery of Type 2.

"Type 2 is of a dwarf habit, producing a dense crown of many leaves, Its initial yield is not as great as that of Type 1, but recovery is better.

"Type 3 is open in the crown and flat, the leaves bluish-green and much dissected. The initial yield and recovery are very much less than in Types 1 and 2. It runs to seed very early, and present indications are that it is a very undesirable type.

"Types 1 and 2 are quite distinct one from the other in appearance. They are possibly equally distinct in feed value and economic adaptation. These points have yet to be proved.

"The trade names under which rape is sold in New Zealand are no indication of its type."

The Influence of Nitrogen, Phosphoric Acid and Potash on the number, shape and weight of Potato Tubers. *William H. Martin, B. E. Brown and H. B. Sprague. Journal of Agricultural Research, Volume* 43, *No.* 3, 1*st August* 1931.—The experiments extended over a period of four years, and comparisons were made of 21 different fertiliser mixtures each containing 15 units of plant food. The longest tubers were produced for the season of greatest rainfall, but this is believed to have been due to the influence of soil moisture content on the availability of the fertiliser rather than to its direct action on the tuber itself.

The longest potatoes were produced by mixtures medium to high in nitrogen and phosphoric acid and low in potash, while the shortest tubers were produced by mixtures with no nitrogen to low nitrogen, low to medium phosphoric acid, and medium to high potash.

When all tubers were considered the largest were found to have been produced by mixtures carrying large amounts of nitrogen with none to small

amounts of phosphoric acid and none to large amounts of potash. The greatest number of tubers in this class was produced by mixtures low in nitrogen, low to high in phosphoric acid, and high in potash, while mixtures high in nitrogen with none to little potash produced fewest tubers. Largest total yielders of tubers in this class were produced by mixtures having both nitrogen and potassium in medium to large amounts, the phosphoric acid being present in small amounts.

Largest total yields of tubers in the 75 gm. class were produced by mixtures carrying medium to high nitrogen, with no potash to high potash, and no phosphoric acid to medium phosphoric acid. Low total yields, on the other hand, were produced by mixtures deficient in either nitrogen or potash. In general, the absence of nitrogen was the most important factor in causing low yields.

Purity Concepts with respect to Crop Varieties. *J. B. Harrington, Scientific Agriculture, Volume XI, No. 7, March* 1931.—Purity definitions and standards had long been a problem and confusion in their interpretation had resulted. Some people in speaking of a seed sample, a variety or a strain used the word *pure* in an absolute sense, and failed to realise that perfect or absolute purity probably never exists in reality. To those who have seriously considered the matter the term *pure* was used relatively. In crops that are frequently or usually cross-fertilised the term *pure* referred to uniformity more or less within wide limits. In grasses and alfalfa *pure* had a meaning that was far from being absolute. In a clonally propagated crop such as potatoes, actual germinal homozygosity might be of no practical consequence. The factors concerned with obtaining or maintaining a high degree of purity in a normally self-fertilised crop such as wheat were listed as :—(*a*) the rapidity of the theoretical approach to homozygosity through the operation of the laws of heredity; (*b*) mutation; (*c*) environmental influences; (*d*) mixtures; (*e*) natural crossing; (*f*) small genetic variation; (*g*) the breeder's technique and judgment.

The Mendelian approach to homozygosity is in reality not the same as it is in theory. Disturbing factors such as admixture, mutation and natural crossing retarded the progress of purification. Mixtures constituted an important factor concerning purity. Regardless of all one could do, some mixtures were almost certain to occur. One very distinct form of mixture deserved special mention and that was natural crossing. At Saskatoon various combinations of wheat varieties had been used, and the amount of natural crossing was found to vary from zero to nearly 10 per cent. No proof of uniformity existed, and no matter how expert the breeder might be, he could not possibly distinguish between small inherited differences and differences caused by environmental influences.

The best of our existing varieties were neither homozygous pure nor uniform, but in comparison with most of the old varieties they were relatively pure. It was probably safe to predict that further approach to uniformity might be expected in new varieties only in so far as new methods of attainment proved to be sufficiently rapid and inexpensive to justify their use. The attainment of greater purity would be looked upon differently by different people. The farmer wanted practical purity with freedom from detrimental admixture and reasonable uniformity for important characters. The breeder's viewpoint was about the same, the seedsman favoured uniformity in so far as it represented greater value and attractiveness to the buyer, but he would probably frown upon an added amount of uniformity if it increased the cost of seed without demonstrating superior value. The average Government official felt that purity standards should be practical. The expression 99·99 per cent. pure meant very little of itself, but in practice it was meant to mean, and actually did represent, a high degree of purity and uniformity. Undoubtedly greater purity and uniformity than we now have could be obtained. The question was how much purity was really needed?

A Simple Test for Predetermining the Culinary Quality of Potatoes as affected by the Accumulation of Soluble Sugars. *Walter M. Peacock and Byron C. Brunstetter. Circular No.* 158, *United States Department of Agriculture, March* 1931.—Potatoes placed in cold storage at temperatures ranging from 32° to 50° F. accumulated sucrose and reducing sugars such as glucose, laevulose, and possibly others, as a result of the hydrolysis of starch. The amount of these soluble sugars appearing in potatoes depends on the temperature and duration of storage.

As a result of an increase in the concentration of soluble sugars in potatoes stored at low temperatures, the potato chips and French fried potatoes brown before the completion of the cooking process owing to the breakdown or caramelization of the sugars. It was strikingly demonstrated that there was a relation between storage temperature, the amount of soluble sugars, and the

extent of browning of the chips. In general, the lower the storage temperature the greater the amount of soluble sugar and the darker the colour of the chips. An excessive accumulation of both reducing and non-reducing sugars produces a sweetness in products made from tubers that is distasteful to many consumers.

Tests for reducing sugars were made on three potato varieties:—Jersey Red Skin, Green Mountain, and Irish Cobbler, previously stored at 32°, 36°, 40°, 50°, 60°, 70° F. for two to six months. The reagents used in the test were (1) Fehling's solution, (2) Benedict's solution, (3) Alkaline Methylene-blue solution, and (4) Picric Acid solution. In every case excellent differentiation between potatoes held at the various storage temperatures, excepting those at 60° and 70°, was obtained; at the higher temperatures little or no sugar was present.

The Picric Acid test for reducing sugar is applicable to the selection of potatoes for chip making, French frying, baking, and, under certain conditions, for boiling.

SOILS.

The Relationship between Root Soluble Potash and the Reaction of a Soil. *L. Schmitt, Ernährung der Pflanze.* 28, 216, 1932.—Analyses of over 2,000 soils have shown that a relationship exists between the soil reaction and soluble potash as determined by the Neubauer method. Alkaline and neutral soils contained more soluble potash than acid soils, and below a pH value of 5·5 soils were in most cases deficient in potash. The relationship is stated to be due to the expulsion of bases from the soil complex by hydrogen as the soil acidity increases.

The Precipitation of Iron and Manganese in Fen Peat. *Paul Dorff, Svenskamosskulturföreningens Tidskrift.* 46, 97, 1932.—Iron and manganese ores often occur in the neighbourhood of peat deposits, and soluble salts are formed by humic acid and to a lesser extent by carbon dioxide in the soil—and rain waters. These compounds are easily oxydised and are often precipitated from solution by atmospheric oxygen. The author draws attention to the fact that bacteria can bring about precipitation of iron in large quantities. In drain-pipes where only a small amount of organic matter is present in solution the organisms (Gallionella) may cause complete stoppage of flow, while in open drains other species (Leptothrix, Ochrobium, &c.) bring about the accumulation of insoluble iron compounds from water containing much soluble organic matter.

Reaction and Phosphoric Acid Content of the Soil. *Dr. S. Gericke, Die Phosphorsäure.* Bd. 2, 1932.—The reaction and total and available phosphoric acid contents of upwards of 1,000 German soils are recorded, and an attempt is made to correlate the degree of acidity of the soil with its phosphoric acid content. The mean content of total phosphoric acid is found to be about 0·10 per cent., but this mean value is generally exceeded in the most acid soils (pH $<$ 4·5). Although these strongly acid soils generally have a higher total content of phosphoric acid, they have less available phosphoric acid (as determined by extraction with dilute citric acid and by the Neubauer seedling method) than alkaline soils, which in turn have less than neutral soils. Evidence is brought forward to show that if a soil is strongly acid (pH $<$ 4·5) liming increases the availability of the soil phosphoric acid up to a certain limit (about pH$=$7·6), above which the availability is decreased by the further addition of lime.

It is pointed out that Neubauer analyses may show a high phosphoric acid deficiency in soils which are greatly in need of lime, in which case more benefit may be derived from liming than from the addition of phosphatic manures.

Support is given to the view that in acid soils the phosphoric acid is bound in an insoluble form by the iron and aluminium, whilst in alkaline soils the phosphoric acid is present as insoluble tricalcic phosphate. Stress is laid on the importance of choosing suitable phosphatic fertilisers according to the reaction of the soil.

DAIRYING.

Factors affecting the Body and Texture of Processed (Crustless) Cheese. *Templeton and Sommer. Journal of Dairy Science.* 15, 29-41.—This article describes the main factors which determine the physical properties of processed cheese. Flavour of course is controlled by the character of the original cheese material from which the crustless cheese is made, but the body

and texture of the processed cheese is materially affected by the reaction and the age of the cheese used, by the type of emulsifier used, by the temperature employed in the processing and by the moisture content. As a result of their investigations, the authors find that in respect of the type of emulsifier used, sodium citrate gives the most desirable body and texture. They find also that one-half per cent. salt is sufficient, a higher addition than this weakening the body of the cheese. The reaction of the original cheese also has an important effect on the body: the desirable reaction (pH 5·6 to 6·1) being best attained by judicious blending of cheeses. An average age of five to seven months in blending mixtures usually gives satisfactory results. Other factors being constant, the body of processed cheese varies inversely as the amount of water incorporated in the cheese.

Cheese Spread. *Templeton and Sommer. Journal of Dairy Science* (1932). *15*, 155-162.—A cheese spread is defined as "any form of packaged cheese that is of such consistency that, at ordinary room temperature, it may be easily spread with a knife." Included in this category are (*a*) cream cheese; (*b*) processed (crustless) cheese of such age and moisture content as to be "spready"; (*c*) processed cheese with concentrated whey or skim milk powder added and of such fat and moisture content that the mixture will spread readily. The authors have concerned themselves mainly with suitable methods of manufacturing the latter type of cheese spread. A full description of the method of manufacture and the conditions which should be observed to secure a finished product with the desirable fat content and spreadability are given. Cheese spreads of this type are worthy of the attention of our dairy factories and milk depôts which have facilities for their manufacture.

ANIMAL BREEDING.

Horses.

Coat Colour in Horses and its Relation to Disease and Age. *L. V. Kondyrev*, 1930. *Proc. IV, Congress Zool., Anat. and Histol. Kiev*, 176-177.—This work was carried out in connection with an anti-glanders campaign in Northern Caucasus where 64,000 horses were examined. A significant correlation was obtained between coat colour and susceptibility to glanders. It was found on comparing the percentage of horses of various colours in a healthy population with that in an affected population, and also many animals which gave a positive reaction for mallein, that the proportion of black horses was lower, while the proportion of brown horses was definitely higher and that bay was still higher, showing that black horses have a lower resistance than horses of other colours. All animals under two years old were eliminated.

In order to avoid error due to unequal distribution of the various coat colours in the different localities, an index of resistance and susceptibility was calculated on the ratio of the percentage of horses of a given colour in a healthy population to the corresponding percentage of horses that gave a positive mallein reaction. The value of the index is as follows:—

Black	$0·92 \pm 0·02$
Chestnut	$0·98 \pm 0·02$
Bay	$1·02 \pm 0·01$
Brown	$1·09 \pm 0·08$
Dark brown	$1·19 \pm 0·04$
Grey	$0·99 \pm 0·02$

The higher resistance of bay and brown animals as compared with black is further confirmed by their greater longevity. The author concludes that colour is an index of the physiological qualities of the animal, and suggests that a study should be made of the variation and resistance under different climatic conditions in relation to the local live stock.

Inheritance of Fertility in the Stallion. *Zuchtungskunde 7, pp.* 58-62. —Microscopic examination of the sperm of a stallion may determine his fertility, which may also be assessed by the percentage of mares which settle in foal to him. Dr. Kisslowsky has studied the stallions in East Friesland and has judged their fertility by the percentage of foals produced. On an average, 136 mares are successfully mated to each stallion in the year. One stallion had during a period of twelve years covered an average of 218 mares per year and gave the relatively high fertilisation figure of 66 per cent. A significant correlation was found between the fertility of the sire and that of his sons.

Cattle.

1. Dairy Herd Improvement through the use of Proved Bulls. 2. Study of Bull Associations in Idaho. *F. W. Atkeson and H. A. Mathiesen. Bull. Nos.* 163 *and* 161. *Univ. of Idaho.*—The first of these bulletins shows the improvement that can be achieved in dairy herds through the use of proven sires. The first section deals with the returns per cow according to the class of bull used by the breeder. In herds headed by pure-bred sires, the average yield of butter-fat per cow was 192 lb. as against 165 lb. in herds headed by unpedigreed or grade bulls. This made a difference of receipts for milk per cow of nearly £3 in favour of those in herds sired by pure-bred bulls.

The authors then deal with a study of 76 bulls in Idaho, and these are arranged according to the average butter-fat production of their daughters. The bull that heads the list is a Guernsey whose daughters averaged 1,630 gallons of milk as compared with their dams' average of 1,400 gallons. This bull increased the butter-fat yield of his daughters as compared with their dams by 50 lb. each.

Compared with this there is another bull which, mated to cows yielding 1,550 gallons, left daughters averaging only 980 gallons. The butter-fat yield of the daughters was also decreased by 200 lb. each. The authors call attention to the fact that a bull which decreases production does not always mean that he is of no value as a dairy sire, but that it does imply that he is a failure in the particular herd involved. They go on to say that there is no surer way of selecting a herd sire that will transmit production than by choosing a bull that has proved his ability by producing high-producing cows.

The second paper deals with the means by which bulls may be kept economically to an age where their daughters come into milk and their true value as herd sires can be properly seen. For this purpose there has been established in Idaho a series of co-operative bull associations which consist of a group of dairymen organized for the purpose of the joint ownership and use of three or more dairy bulls Each bull represents a unit or block of the association and the bulls are rotated every two years.

The first of these associations was organized in Michigan in 1908, but within recent years they have been spreading throughout the United States. The average numbers per association are 31 members, 4·6 bulls and 200 cows. This gives an average of 6·8 members and 43 cows per bull. Idaho has the largest number of these associations and the present bulletin is a survey of the work accomplished by them and of their organisation, with conclusions as to how they might be improved.

Before the organization of these societies the members had invested in their bulls approximately 82 dollars per member, but after the organization this figure was reduced to 68 dollars despite the fact that the average value of the bulls in use had been trebled, showing that better bulls were being used at a lower cost to the breeder. All this was due to better distribution of investment. The association bulls were found to be not only cheaper in original cost than previously owned bulls, but the cost being distributed over a longer period weighed less heavily upon the owners of the cows.

Heifers sired by association bulls sold for an average of £2 per head more than calves by other bulls in the community. The simplest solution of the problem of keeping a bull was found in the placing of it on the farm of a man owning a large herd. This man was responsible for keeping the bull at his own expense for the privilege of having the bull convenient and to eliminate the necessity of leading so many cows to the bull. In practice, it was found that if such a man were not a member he would be forced to keep a bull of his own but by joining the association he obtained a higher quality of bull for less money. The chief difficulty was in finding a man centrally located to justify this arrangement. The method of locating the bull at a central point and the members contributing to its cost, though ideal on paper, did not work out particularly well in practice. Several associations had the practice of the bull being rotated from one farm to another. In this case it was frequently found that owners did not know at which farm a bull would be located at any given date.

In order to control disease, certain rules are enforced requiring all animals tested to be free from tuberculosis, and that cows served on more than three different heat periods should be examined by a veterinary surgeon. The constitution of the different associations varied somewhat, but as a rule there was a pool into which was placed a contribution from each member according to the number of cows he possessed sufficient for the purchase of the three or four bulls required for the association. Blocks representing the breeders of

sufficient cows for each bull were then made up, and the location of the bulls to each block was decided by the drawing of names from a hat. At the time of organisation the number of cows per herd was 5, but this figure has now been increased to 8.

This method of stock improvement has met with great success in the United States, particularly where smallholders are concerned. Bull associations tended to develop better dairy practices, such as tuberculin testing, better feeding methods, cleaner handling of the milk, &c.

An Inherited Udder Abnormality in Cattle. *Edwin E. Heizer.* 1932. *Jour. Hered., Vol.* 23, *No.* 3, *pp.* 111-114.—This abnormality has been reported from Ohio State University. On one side the udder of the cow is normal but on the other side, usually the left, only one quarter with one teat is present. It is very objectionable and materially affects the usefulness of the cows. Such animals are difficult to milk and consequently the owners have used them for nursing calves. The left half of the udder is nearly as large and almost the same shape as the right half. The character has been found only in Guernsey cattle, but there is reason to believe that Dr. C. W. Turner of Missouri has also found it in the Hereford breed. All the evidence points towards its being inherited as a simple mendelian recessive. The factor is of great economic importance to breeders in dairy cattle as, owing to its recessive nature, its presence may be disseminated throughout an entire herd before an abnormal individual appears. Special attention should be paid to this point in the selection of bulls. The writer recommends that the best way to stamp out this undesirable factor would be for the breed associations to insert a clause in their registration requirements which would prevent registration of individuals, either male or female, which did not show normal udder development.

It is certainly a point against which breeders in this country must be on their guard.

Prize-winning Shorthorns. *E. E. Brockelbank and L. M. Winters.* 1931. *Jour. Hered., Vol.* 22, *No.* 8, *pp.* 245-249.—This study was undertaken to find out how the best Shorthorns in the United States have been produced and whether inbreeding or outbreeding played an important part. For the purpose of this paper, a list was compiled of the 1st and 2nd prize-winners at the International Livestock Show from the years 1900 to 1928. A second list was made of 100 animals chosen at random from the volumes of the Herd Book in which the present-day show winners are recorded. Thus the pedigrees of 200 animals were tabulated to the sixth generation. It was found that the average co-efficient of inbreeding for the present day was 2·06, while that of the random selected individuals was 1·03. On the whole the authors are of the opinion that inbreeding has not been a factor in the production of show-winning Shorthorns and that the breeders have not practised outcrossing to an appreciable extent. The show winners do tend to produce show winners. The writers, however, point out that this does not imply that inbreeding could not be used effectively for the production of breed animals and outcrossing for the production of show animals.

The Sex Ratio and Multiple Births in Cattle. 1932. *Ivar Johansson, Ultuna Agricultural College, Upsala, Sweden. Zeit. f. Zucht. Reihe B. Tier. und Zucht. Einschliesslich Tierernahrung, Band* XXIV, *Heft* 2, *pp.* 183-268.—The frequency of multiple births is to a great extent a breeding characteristic. Twins are commoner amongst the Swedish Friesians than among the red and white cattle or the Swedish Landrace. They would also appear to be commoner in dairy than in beef breeds.

The age of the mother has a pronounced effect on the tendency towards multiple births, which increases up to the age of about 8 or 9 years. The age of the bull at the time of mating seems to be of no importance in this respect. In the Swedish and Finnish breeds of cattle, there is a significant variation in the frequency of multiple births. Two yearly maxima are observed : one in the months of June and July and another in December and January; the second being less pronounced than the first. The seasonal variation in twinning is held to be due principally to climatic conditions which affect the number of ova which the cow may shed.

The writer comes to the conclusion that the quality of the feed affects the fertility of the cows but has very little to do with the question of twinning, whereas the quantity of the feed may, on the other hand, have a certain influence on multiple births. Several instances are given which show the inheritance of twinning.

Sheep.

Sextuplet Lambs. *J. F. Wilson and D. W. Gregory.* 1931. *Jour. Hered.*, *Vol.* 22, *No.* 7, *pp.* 229-230.—This is a note of an event which the writers claim to be a record. The ewe in question lived in California and was a pure-bred Romney. She was born in April 1926 and was five years old when she dropped six lambs. At the Institute of Animal Genetics in Edinburgh there is a record of a ewe in the possession of Mr. James Cattow, Auchincruive, which gave birth to sextuplets, and followed this the next year by five and then four and then five again.

ANIMAL NUTRITION.

Feeding of Colts. *Ch. Hambrouck, J. des Agriculteurs de Belgique,* 1931, *No.* 2, 11.—At birth the food should be mother's milk, or in default of it, cow's milk diluted with water and with added sugar. Later a gradual change may be made to whole cow's milk. Weaning may be gradual or abrupt according to circumstances. On pasture in fine weather a supplement of crushed oats should be given, in small quantities at first, increasing to 6 litres (equivalent to two-thirds of a peck) per day, with linseed meal and cake. If the colt must be kept indoors the ration should be of oats, bran and hay. After the first year pasture in summer is the only feed required, in winter, hay, oats, beetroot or carrots, bran and linseed meal. The following ration is suitable for heavy draft colts in their first winter: oats (1 part), bran (2 parts), beans (3 parts), hay (7 parts), and carrots (7 parts).

Potatoes for Dairy Cows. *J. R. Dice. Agric. Exp. Stat., N. Dakota Agric. Coll., Bull. No.* 249, *June* 1931. (1 *fig.*, 21 *refs*) (*Fargo, N. Dakota.*)—Two series of trials were carried out to test the value for milk cows of potatoes as compared with corn silage. In the first the cows were fed what they could eat of potatoes or corn silage. In the second the cows received 40 lb. potatoes or 40 lb. silage per day. The rest of the ration, which was fed according to production, consisted of a mixture made up of 200 lb. each ground oats and ground barley, 100 lb. ground corn, 7 lb. bone meal, and 4 lb. salt, with alfalfa hay. Potatoes were found to be a useful feed to dairy cows up to from 25 to 40 lb. per day, on which amounts as much milk and fat were produced as from corn silage.

The Rationing of Baby Beef. *R. H. Common. J. Minist. Agric.* (*N. Ireland*), 1931, *3*, 34-48. (8 *refs.*) (*Agric. Res. Inst., N. Ireland.*)—Three experiments carried out 1928-30 show that calves sired by a Shorthorn bull out of cross-bred Galloway cows if run with their dams for 5-6 months can be raised to good quality baby beef, 7-8 cwt. at 13 months old, and that there is no evident advantage to be gained by departing from the normal standards of protein and dry matter requirements for such cattle. The bulk of the food fed was home-grown, and it is claimed here that for feeding off 6 month-old calves, previously well fed, there is no need for costly imported feeding-stuffs.

Rearing Sucking Pigs. *V. C. Fishwick. J. Minist. Agric.* (*Engl.*), 1931, *38*, 898-903. (2 *figs.*) (*S.E. Agric Coll., Wye, Kent.*)—Experiments were carried out with spring and autumn farrowed pigs to determine the value of a run-out on grass. In one group the sows and litters were allowed out to grass at will; in the other, sows were allowed to graze for two hours daily, but the litters were confined to sties. Special attention was paid to the health of the pigs in the two groups. At five or six weeks old the pigs in the group with run-out were considerably heavier than those confined indoors. All suffered from scour, but it was more difficult to control in the indoor pigs, which also developed pica. Anæmia also developed in the autumn-farrowed indoor pigs. The outdoor pigs started to eat at four weeks, the indoor at between five and six. The incidence of parasitic worms was heavy in the outdoor pigs on a small run, and this may occasion heavy losses if runs are not changed frequently.

Dominion of Canada Dept. Agric., Animal Husbandry Div., Report for year ending March 1931. *G. B. Rothwell.* 44 *pp.*—The following are two of the more important results quoted in the report.

Iodine.—Three groups of pigs were used to test the effect of feeding potassium iodide at the rates of 1/15,000 lb. and 1/30,000 lb. per pig daily. The basal ration consisted of cereals, linseed meal and tankage. There was no significant difference in the rates and economy gains in live weight of the different groups.

This result confirms previous findings in a district considered to be semi-iodine-deficient.

Iron.—It was found in an experiment with 12 pigs divided into three groups of four that the addition of iron oxide and of iron oxide and copper sulphate resulted in a better maintained blood hæmoglobin content and in more economical though rather less rapid live-weight gains.

Value of Sugar in Pig Feeding. *G. Fröhlich and H. Lüthge. Ztschr. f. Schweinezucht*, 1931, *38*, 693-696. (11 *refs.*) *Inst. Animal Husb. and Dairying, Univ., Halle-Saale.*—Feeding-sugar is shown to replace satisfactorily a proportion of the cereal mixture in a ration for fattening pigs. Pigs which received 8 per cent. of sugar in a ration of cereals, fish meal and potatoes gave slightly better returns than pigs which did not receive sugar. The quantity of sugar was increased with the age of the pig, and was able to replace 50 per cent. of the cereal mixture without producing harmful results in the final stages of fattening. The money value of sugar for pig feeding is seven-tenths that of barley.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in March, April and May 1932.

Live Stock : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	March.			April.			May.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*Cattle—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	53 6	46 4	43 2	52 11	46 6	43 0	53 0	46 9	...
Cross-bred (Shorthorn)	48 8	43 6	35 8	48 9	44 2	35 9	49 5	44 4	35 2
Galloway	47 7	42 5	...	49 0	43 9	..	51 4	45 6	...
Ayrshire	42 0	34 1	28 0	42 0	33 9	28 0	41 9	33 3	27 11
Blue Grey	.	...	...	..	..	..	...		...
Highland	42 6	...	.	...	...	...	...		...
	per lb. d.	per lb d	per lb d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb d	per lb. d.
†Veal Calves	16	7	...	15¾	7	...	15	7	...
	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.
†Sheep—	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d	per lb. d.	per lb. d	per lb d.	per lb. d.
Cheviot	9¾	8¼	7½	9¾	7¾	7½	9	7¼	6¾
Half-bred	9½	8¼	7¼	9¼	8	7	8¼	7½	6¾
Blackface	10	8½	7½	9½	8¼	7½	9	7¾	7
Greyface	10¼	9¼	7½	10	8¾	7½	9½	8½	7
Down Cross	10	9	7	10	9¼	6¾	9¾	8¾	6
†Pigs—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s d	per stone. s. d.
Bacon Pigs	8 8	7 11	...	8 7	7 10	...	8 6	7 11	...
Porkers	9 11	9 1	...	9 10	8 11	...	9 6	8 8	...

* Live weight. † Estimated dressed carcase weight.

Live Stock : Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	March.			April.			May.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
CATTLE—	Per head.	Per head.	Per head	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	16 7	12 10	11 15	17 0	12 19	11 14	16 14	12 18	10 0
Two-year-olds ...	22 2	17 11	14 10	21 11	17 7	13 8	21 17	17 6	13 4
Cross-bred (Shorthorn):									
Yearlings	15 13	12 2	10 10	15 10	12 1	10 13	15 9	11 18	9 10
Two-year-olds ...	20 14	16 2	13 15	20 6	16 3	12 8	20 8	15 19	12 0
Galloway :									
Yearlings	14 6	10 10	...	15 5	14 0	...	14 9	11 5	..
Two-year-olds ...	..	16 13	...	20 10	17 10	...	22 15	18 10	...
Ayrshire :									
Yearlings	...	..	..	10 19	...	...	11 12	10 10	...
Two-year-olds ...	...	...	...	14 15	...	...	15 16	14 10	..
Blue Grey :									
Yearlings	...	...	...	16 5	...	...	...	...	...
Two-year-olds ...	...	...	...	24 15	...	...	...	...	...
Highland :									
Yearlings		..	.	...	...	...	...	9 0	7 10
Two-year-olds ...	...	. .	...	...	.	...	13 10	11 15	10 0
Three-year-olds ..	...	..	..	...	...	...	...	...	...
DAIRY COWS—									
Ayrshire :									
In Milk	23 6	16 14	11 0	24 0	17 8	11 10	23 10	16 15	11 7
Calvers	24 3	18 2	13 3	25 8	18 10	13 13	25 3	18 12	14 0
Shorthorn Cross :									
In Milk	28 12	19 18	...	27 18	20 6	...	28 0	20 17	...
Calvers	26 11	19 18	14 4	26 6	19 17	14 15	26 2	18 17	14 6
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	35 4	24 10	19 6	30 9	22 5	19 0	27 5	20 6	...
Half-bred Hoggs ...	42 0	29 5	...	41 9	29 0	...	40 0	27 9	...
Blackface Hoggs ...	24 8	17 0	...	25 10	19 3	15 5	25 8	18 10	15 0
Greyface Hoggs ...	33 7	26 0	23 7	32 5	24 11	20 6	33 0	25 7	21 6
Down Cross Hoggs	33 7	23 8	...	...	25 0	...	...	...	. .
PIGS—									
(6 to 10 weeks old)	23 8	14 4	...	23 10	14 0	...	24 0	14 3	...

DEAD MEAT : Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	March.			April.			May.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF :—										
Home-fed—										
Bullock or Heifer ...	1	8¼	8¼	9¼	8	8¼	9¼	8⅛	8¼	9¼
	2	7⅝	...	7⅞	7¾	...	8¼	7¾	...	8⅜
Bull	1	6¼	6	6	6¾	6⅛	6	6⅝	6½	6⅛
	2	5½	...	5	5¾	...	5	5⅝	6	5⅜
Cow	1	5⅜	5⅜	5⅞	5¾	5⅞	6⅛	5⅝	5⅝	6
	2	4⅞	...	4½	5	...	4¾	4⅞	...	4⅞
Irish—										
Bullock or Heifer ...	1	...	...	8¼	...	...	8½	...	...	...
	2	...	...	7½	...	...	8	...	...	...
Bull	1	...	...	...	...	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	...
Argentine Frozen—										
Hind Quarters ...	1	4½	5½	...	5	5½	...	...	6⅜	...
	2	4	3¾	...	...	4½	..	...	4¾	...
Fore „	1	3⅝	3¾	...	4	4⅜	...	...	4⅝	...
	2	..	3	..	...	3¾	...	...	4½	...
Argentine Chilled—										
Hind Quarters ...	1	6⅜	6¼	6¼	6¾	6⅝	7¼	6⅝	6½	6⅝
	2	4¾	5⅝	5¼	5¾	6	6⅝	...	5⅝	5⅞
Fore „	1	4⅛	4⅛	4	4¾	4¾	5	4⅝	4⅞	4⅝
	2	3½	3¼	3¾	4½	4¼	4¾	...	4½	4⅜
Australian Frozen—										
Hind Quarters ...	1	...	...	3¾	...	...	4⅝	...	...	4⅞
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	2¾	...	...	4⅛	...	...	4⅝
	2	..	...	...	...	...	...	..	...	...
New Zealand Frozen—										
Hind Quarters ...	1	..	...	3¾	...	...	4⅝	...	...	5
	2	..	...	...	...	...	...	...	...	...
Fore „	1	...	..	2¾	...	...	3⅞	...	...	4½
	2	...	...	...	...	...	...	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	9⅜	8	9¼	8½	8	9½	8⅛	8⅜	8⅞
	60 lb. & over	8¼	...	8⅝	8	7¾	8¾	7⅝	...	8¼
„ Cross	under 60 lb.	9⅛	8	9¼	8½	8	9½	8¼	8⅜	8⅞
	60 lb. & over	8¼	...	8⅝	8	7¾	8¾	7⅝	...	8¼
Ewes, Cheviot	1	...	6⅝	7⅜	...	6⅝	7¾	...	6	7⅛
	2	...	...	6½	...	..	7⅛	...	...	6¾
„ Blackface ...	1	7⅛	6⅝	7⅜	7½	6⅝	7¾	7¼	6	7⅛
	2	6¼	...	6½	7	...	7⅛	6⅝	...	6¾
„ Cross	1	5⅞	6⅝	7⅜	6	6⅝	7¾	5⅝	6	7⅛
	2	4⅞	...	6½	5	...	7⅛	4⅝	...	6¾
Argentine Frozen ...	1	...	...	3¾	..	...	3¾	...	...	3¾
	2	...	...	...	...	...	...	...	...	..
Australian „ ...	1	...	4¾	3½	...	4⅝	3¾	...	4⅜	3¾
	2	...	3⅝	...	...	3⅜	...	...	3⅛	...
New Zealand „ ...	1	...	...	3⅝	...	...	4	...	..	4⅛
	2	...	...	3⅜	...	...	3½	...	...	3¼
LAMB :—										
Home-fed	1	...	...	9⅜	...	...	9½	...	13⅝	12⅝
	2	...	...	8⅝	...	...	8¾	...	...	9⅛
New Zealand Frozen ...	1	...	7¼	7	...	7⅜	7⅛	...	7⅛	6⅞
	2	...	6½	6	...	6⅞	6⅛	...	6½	6⅛
Australian „ ...	1	...	...	5½	...	...	5⅞	...	...	6⅛
	2	...	...	...	...	...	...	...	...	...
Argentine „ ...	1	...	...	5¼	...	...	5⅝	...	...	6
	2	...	...	...	...	...	...	...	...	..

Eggs: Monthly Average Wholesale Prices at Aberdeen and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Market.	Description.	Quality.	March.	April.	May.
			s. d.	s. d.	s. d.
Aberdeen.	Country ... ... per doz.	1	0 11	0 11	0 11
		2	0 10	0 10	0 10
	Duck .. ... ,,	1	1 0	1 0	1 0
		2	0 11	0 11	0 11
Glasgow.	Country .. ... per doz.	1	1 1	1 0	1 0
		2	...	0 11	0 11
	Irish .. ... per 120.	1	10 10	10 2	9 4
		2	9 7	8 9	8 3
	,, (Duck) ... ,,	1	13 1	8 8	8 6
		2	12 5	7 11	8 1
	,, (Free State) ... ,,	1	...	8 6	8 6
		2	...	7 10	7 11
	Belgian .. .. ,,	1	9 4	8 3	9 5
	Polish ... ... ,,	1	8 8	6 9	6 4

Provisions: Monthly Average Wholesale Prices at Glasgow.

Description.	Quality.	March.	April.	May.
		s. d.	s. d.	s. d.
Butter:				
Australian ... ... per cwt.	1	112 0	111 6	102 3
Danish ... ... ,,	1	129 0	119 6	107 9
,, (Unsalted) ... ,,	1	134 0	125 0	112 9
New Zealand ... ... ,,	1	114 5	111 9	102 3
,, (Unsalted) ... ,,	1	122 10	121 6	109 6
Siberian ... ... ,,	1	111 5	110 0	110 0
Swedish ... . ,,	1	126 0	118 6	107 3
Cheese:				
Cheddar ... ... ,,	1	84 10	81 6	79 0
	2	77 7	75 6	72 0
Cheddar Loaf .. ... ,,	1	100 0	100 0	100 0
	2	97 7	96 0	84 8
Dunlop ... ... ,,	1	96 0	96 0	80 6
	2	94 0	94 0	96 0
Canadian ... ... ,,	1	76 0	76 0	76 9
New Zealand (White) ,,	1	69 2	67 0	64 9
,, (Coloured) ,,	1	69 2	67 0	64 3
Hams:				
Irish (Smoked) ... ... ,,	1	133 0	149 6	164 6
	2	120 0	136 6	151 6
American, Long Cut (Green) ,,	1	78 0	82 0	88 3
,, Short Cut ... ,,	1	73 5	72 6	75 3
Bacon:				
Wiltshire (Green) ... ,,	1	98 0	99 0	107 0
,, (Dried or Smoked) ,,	1	104 0	105 0	112 6
Ayrshire (Rolled) ... ,,	1	98 0	98 6	102 6
Irish (Green) ... .. ,,	1	89 7	96 0	98 6
,, (Dried or Smoked) ,,	1	95 7	101 0	104 0
,, (Long Clear) ... ,,	1	80 10	90 0	94 0
Danish, Sides ... ... ,,	1	58 10	59 6	71 6
Dutch, Green (Wiltshire Style) ,,	1	51 2	52 3	67 3
Polish, Green ,, ,, ,,	1	47 2	48 9	65 9

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.		Quality.	MARCH.	APRIL.	MAY.
FRUIT:—					
Apples—			s. d.	s. d.	s. d.
American ...	... per case.*	1	12 1	12 0	13 8
,, ...	... per barrel.†	2	29 0	39 0	38 0
Australian ...	... per case.*	1	...	14 3	11 5
Tasmanian ...	... ,, *	1	...	12 0	11 0
New Zealand	... ,, *	1	...	11 3	11 10
Pears, Californian	... per case.*	1	17 6	16 9	10 0
,, South African ...	,, ‡	1	...	5 0	7 6
VEGETABLES:—					
Beet	... per cwt.	1	10 0	10 0	12 9
Brussels Sprouts	... ,,	1	14 0	..	...
Cabbage, Coleworts	... per doz.	1	0 11	0 11	1 0
,, Red ...	... ,,	1	2 10	2 6	2 11
,, Savoy ...	... ,,	1	1 8	1 8	...
Carrots, ...	... per cwt.	1	8 0	13 0	23 3
Cauliflowers—					
Broccoli, Cornish	... per doz.	1	4 10	5 2	5 0
French ...	... ,,	1	5 6	5 7	5 2
Cucumbers ...	... per doz.	1	8 9	6 9	6 0
Greens	per 120 heads.	1	10 0	10 0	10 0
Leeks	per doz. bunches.	1	2 6	2 6	2 8
Lettuce, Cabbage	... per doz.	1	3 4	2 6	2 5
Onions, *Spring* ...	... per bunch.	1	0 6	0 5½	0 5½
,, *Egyptian*	... per cwt.	1	10 7	13 11	12 5
,, *Dutch* ...	... per bag.**	1	18 0	...	.
,, *Valencia*	... per case.¶	1	17 11	12 3	9 0
Parsley	... per cwt.	1	20 10	35 6	40 0
Parsnips	... ,,	1	7 0	7 9	8 0
Radishes	per doz. bunches.	1	1 11	1 7	1 5
Rhubarb	... per cwt.	1	33 2	19 0	5 0
Spinach	.. per stone.	1	4 0	4 0	4 0
Tomatoes—					
Scottish	per lb.	1	...	...	1 5¾
English	,,	1	...	1 11	1 8
Channel Islands ...	,,	1	0 5½	1 1¼	1 2½
Canary	,,	1	...	0 4¾	0 6
Dutch	,,	1	...	...	0 8¼
Turnips	... per cwt.	1	2 0	2 2	2 7

* 40 lb. (approx.). † 9 stone (approx.). ‡ 25 pears.
** 7½ stone (approx). ¶ 9 stone (approx.).

POTATOES: Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Golden Wonder.	Late Varieties. Other Soils. Other.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
MARCH.							
Aberdeen, per ton	1	...	...	...	...	9 12 0	8 10 0
Dundee ,,	1	...	...	...	...	...	8 4 0
Edinburgh ,,	1	...	9 0 0	10 0 0	9 6 8	9 17 0	9 0 0
Glasgow ,,	1	...	...	...	...	10 7 0	8 8 6
APRIL.							
Aberdeen ,,	1	...	...	...	...	9 8 9	8 1 3
Dundee ,,	1	...	...	...	...	..	7 18 9
Edinburgh ,,	1	...	...	10 0 0	9 5 0	9 5 0	8 17 6
Glasgow ,,	1	...	...	...	...	10 6 3	8 5 0
MAY.							
Aberdeen ,,	1	...	...	...	...	9 9 6	8 5 0
Dundee ,,	1	...	...	...	...	...	8 0 8
Edinburgh ,,	1	...	...	9 10 0	9 0 0	9 1 8	8 5 11
Glasgow ,,	1	...	...	...	...	10 2 6	8 4 5

ROOTS, HAY, STRAW AND MOSS LITTER: Monthly Average Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
MARCH.										
* Aberdeen, per ton	1	...	...	...	55 0	...	...	...	35 0	...
‖ Dundee ... ,,	1	...	11 7	14 2	90 0 a 80 0 b	...	63 0	...	63 0	55 6†
¶ Edinburgh ,,	1	...	...	...	65 0 a 62 6 b	...	45 0	...	40 0	...
‖ Glasgow ,,	1	...	...	...	60 0 a	65 0 a	45 0	..	41 0	32 6‡
APRIL.										
* Aberdeen ,,	1	...	...	..	55 0	...	...	...	35 0	...
‖ Dundee ... ,,	1	...	...	14 6	90 0 a 75 0 b	...	65 0	...	65 0	55 6†
¶ Edinburgh ,,	1	...	...	...	65 0 a 62 6 b	...	40 0	35 0	40 0	...
‖ Glasgow ,,	1	...	...	...	60 0 a	65 0 a	45 0	...	40 0	32 6‡
MAY.										
* Aberdeen ,,	1	...	...	...	55 0	...	...	...	31 8	...
‖ Dundee ... ,,	1	...	...	15 3	90 0 a 75 0 b	...	65 0	...	65 0	52 6§
¶ Edinburgh ,,	1	...	...	...	65 0 a 62 6 b	...	40 0	...	40 0	...
‖ Glasgow ,,	1	...	...	...	60 0 a	65 0 a	45 0	...	40 0	32 6‡

* Loose, ex farm.
‖ Baled straw, delivered.
¶ Bunched straw, delivered.

a Baled and delivered.
b Delivered loose.

† Dutch, delivered in town.
‡ Home (in 1½ cwt bales).
§ At quay.

FEEDING STUFFS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	March.		April.		May.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	8 9 6	8 2 0	8 4 8	7 16 3	8 0 0	7 15 0
Foreign	8 7 6	7 18 0	8 5 8	8 0 0	8 2 6	...
Decort. Cotton Cake	8 6 0	...	8 6 3	...	8 5 0	...
Undecorticated do.—						
Egyptian	5 9 6	5 5 6	5 2 6	5 0 8	5 0 0	5 0 0
Palmnut Kernel Cake	8 10 0	...	8 10 0	...	7 15 0	...
Coconut Cake ...	8 15 0	...	8 15 0	...	8 3 9	...
Groundnut Cake, Undecorticated—						
(37% Oil, etc.) ...	...	...	...	7 1 3	...	7 0 8
(40% do.) ...	...	8 3 0	...	8 0 0	...	7 17 6
Maize Germ Cake—						
Home-Manufactured	7 19 0	...	7 10 0	...	7 11 7	...
Maize Germ Cake Meal	6 6 6	...	6 8 4	...	...	...
Rice Meal	5 14 9	...	6 0 0	...	5 19 5	...
Bean Meal	9 9 6	9 5 0	9 4 8	9 0 0	9 0 0	8 5 0
Barley Meal ...	8 5 0	7 16 0	8 1 11	8 0 0	8 2 6	8 0 0
Fish Meal	15 6 6	15 10 0	15 4 5	15 7 6	15 1 3	15 1 11
Maize Meal—						
Home-Manufactured	6 7 6	6 5 6	6 3 2	6 3 9	6 2 6	6 2 6
South African—(Yellow) ...	6 2 6	6 0 0	5 18 2	6 0 0	5 18 5	...
Locust Bean Meal (Fine)	7 0 0	6 0 0	7 0 0	6 0 0	7 0 0	6 10 0
Maize Gluten Feed (Paisley)	5 15 0	..	5 14 5	...	5 13 9	...
Maize—						
Plate	5 7 0	5 7 0	5 6 3	5 2 6	5 6 7	5 3 2
African, Flat ...	6 5 0	6 5 0	6 6 3	...	6 7 6	...
Oats—						
Home	8 7 0	8 10 0	8 3 9	8 6 8	8 11 11	8 12 6
Plate	6 8 9	6 11 11	6 9 5	6 8 9	6 12 6	6 15 0
Canadian No. 2 ...	8 7 6	8 5 0	8 0 0	...	8 3 9	8 10 0
Do. No. 3 ...	8 1 0	...	7 18 9	...	7 19 1	...
Barley, Feeding, Home	7 6 0	6 16 0	7 9 5	7 0 0	7 10 0	7 0 0
Wheat—						
Home	7 15 0	7 0 0	7 13 5	7 1 3	7 9 3	7 5 0
Poultry	7 5 0	...	7 5 0	...	7 6 3	...
Imported... ...	7 11 9	6 19 0	7 3 2	7 0 0	7 3 9	7 0 0
Middlings (Fine Thirds or Parings)	7 14 0	6 18 0	7 11 11	6 16 3	7 11 3	7 0 0
Sharps (Common Thirds) ...	6 15 6	6 5 0	6 8 5	6 5 0	6 8 5	6 5 0
Bran (Medium) ...	6 14 3	6 12 0	6 8 2	6 5 0	6 8 2	6 5 0
,, (Broad) ...	6 18 3	7 7 0	6 16 7	7 0 0	6 10 8	7 2 6
Malt Culms... ...	5 13 3	...	5 11 3	...	5 10 8	5 15 0
Distillery Mixed Grains—Dried	7 10 0	7 9 2	6 19 2	8 2 6	7 1 8	8 2 6
Brewers' Grains—						
Dried	7 6 9	...	6 15 8	...	6 9 1	5 15 0
Distillery Malt Grains —Dried	8 5 9	...	7 8 5	...	7 5 0	...
Crushed Linseed ...	15 0 0	...	15 0 0	...	15 0 0	...
Locust Beans, Kibbled and Stoned	6 0 0	5 10 0	6 0 0	5 10 0	6 0 0	..
Beans—						
China	8 10 0	8 12 0	8 5 4	8 8 2	8 7 6	8 4 5
English	8 12 3	...	8 7 10	...	8 8 2	...
Rangoon (White)	7 5 0	...	7 5 0	...	...	...
Persian	8 12 6	...	8 14 5	...	8 12 6	...
Pease—						
Calcutta (White)	...	...	8 17 6	...	8 17 6	...
Russian (do.)	...	...	8 10 10	...	8 11 3	...
Feeding Treacle ...	5 4 6	5 10 0	5 0 0	5 10 0	5 0 0	5 13 9
Linseed Oil, per gall.	0 3 1	0 2 3	0 3 0	...	0 3 0	0 2 0

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	March. Glasgow.	March. Leith.	April. Glasgow.	April. Leith.	May. Glasgow.	May. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda § ...	N. 15·5	8 19 2	9 0 0	9 0 0	9 0 0	9 0 0	8 18 0
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	7 0 0	7 0 0	7 0 0	7 0 0	6 8 9	6 8 9
Nitrochalk § ...	N. 15·5	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0
Superphosphate ...	P.A. 13·7	2 7 6	2 12 6	2 7 6	2 12 6	2 7 6	2 12 6
,, ...	,, 16·0	2 12 6	2 17 6	2 12 6	2 17 6	2 12 6	2 17 6
,, ..	,, 18·3	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6
Ground Mineral Phosphate *a*	P.A. 26	2 7 6	...	2 7 6	...	2 7 6	...
,, ,, ,, *b*	,, 26	...	2 5 0	..	2 5 0	...	2 5 0
,, ,, ,, *a*	,, 34	3 7 6	...	3 7 6	...	3 7 6	...
,, ,, ,, *b*	,, 34	...	3 5 0	...	3 5 0	...	3 5 0
Potassic Mineral Phosphate	P.A. 18 Pot. 9	3 11 3	...	3 11 3	...	3 11 3	...
,, ,, ,,	P.A. 21 Pot. 6	3 6 3	...	3 6 3	...	3 6 3	...
Kainit (in bags) ..	Pot. 14	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6
Calcium Cyanamide ‡	N. 20·6	7 0 0	...	7 0 0	...	7 0 0	...
Potash Salts ...	Pot. 20	3 18 9	...	3 18 9	...	3 18 9	...
,, ,, ...	Pot. 30	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	10 5 0	10 5 0	10 5 0	10 5 0	10 5 0	10 5 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	12 12 6	12 12 6	12 12 6	12 12 6	12 12 6	12 12 6
Steamed Bone Flour	N. 0·8 P.A. 28	5 5 0	5 5 0	5 12 6	...	6 0 0	..
Bone Meal (Home)	N. 3·3 P.A. 22·9	6 15 0	..	...	...	...	...
,, ,, (Indian)	N. 4 P.A. 20	7 0 0	7 5 0	7 0 0	7 5 0	7 0 0	7 5 0
Basic Slag † ...	P.A. 11	1 19 0	...	1 19 0	...	1 19 0	...
,, ,, ..	,, 12	2 1 6	...	2 1 6	...	2 1 6	..
,, ,, .	,, 13	2 4 6	...	2 4 6	...	2 4 6	...
,, ,, ...	,, 14	2 7 0	*1 15 0	2 7 0	*1 15 0	2 7 0	*1 15 0
,, ,, ...	,, 15·75	2 11 0	*2 0 0	2 11 0	*2 0 0	2 11 0	*2 0 0
,, ,, ..	,, 16·5	2 14 0	...	2 14 0	...	2 14 0	...
,, ,, ...	,, 17·5	2 18 0	...	2 18 0	...	2 18 0	...

Abbreviations:—N. = Nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

§ Carriage paid, in 6-ton lots. ‡ Carriage paid, in 4-ton lots.
a Fine grist: 90 per cent. fineness through prescribed sieve.
b Fine grist: 85 to 90 per cent. fineness through standard 100-mesh sieve.
† Prices for Basic Slag at Glasgow—F.o.r., in 6-ton lots, 80 per cent. citric soluble.
* F.o.r., Bo'ness. Prices at Leith higher by 5s. 6d. per ton.

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MECHANISED FARMING AND LIVE STOCK PRODUCTION.

Professor J. A. S. Watson, M.C., B.Sc., and Dunstan Skilbeck, M.A.

School of Rural Economy, Oxford.

Up till the last year or so the arable farmer, and particularly the man who is largely dependent upon the sale of grain, has been bearing the brunt of the agricultural depression. Not only have the prices of his main products been abnormally low, but his labour costs have remained relatively very high, while falling prices for live stock have often deprived him of any margin of profit on his wintering or winter-fattening stock. It is therefore only natural that we should see an attempt being made to revolutionise our methods of cereal production. This is taking the form of substituting the big tractor for the horse and of introducing, from overseas, large labour-saving implements, such as the combine harvester. On the whole the technical difficulties of applying such methods to grain growing, in the typical grain-growing districts of England, are proving less serious than most people expected. No doubt now remains that, given a unit of economic size, the cereal crops can be grown and harvested quite successfully by the new methods, and with a very striking reduction in labour costs. If then the main problem of the home industry were to "make corn-growing pay" it might be said that some progress was being made towards a solution of our difficulties.

But most of the mechanised farms that are so far being run as commercial concerns are completely specialised. They grow nothing but grain and carry no stock. The farmer relies upon artificials and an occasional green manuring crop for keeping up the fertility of his land, and upon stubble cultivations and bare fallows for the keeping down of weeds. It would indeed seem that, at any rate on certain soils, profitable yields can be maintained by such means. It must, however, be borne in mind that the production of saleable grain has become a relatively unimportant part of our home agriculture. We produce only some ten per cent. of our requirements of wheat; our barley acreage has suffered a severe decline; the market for oats is going down, and seems bound to go down still more with the decline of horse transport in cities. On the other hand, we still rely upon our home industry for some 50 per cent. of our meat, and for 47 per

cent. of our dairy produce. Over 70 per cent. of our total agricultural output is marketed in the form of live stock and live-stock products, while farm sale-crops, fruit and market garden produce, account for less than 30 per cent. Taking the country as a whole, the most important function of our arable land is not to produce marketable grain, but to grow winter food for stock.

During the last year or two the collapse of prices has spread to the majority of live-stock products. In particular sheep, pigs, and eggs have fallen to about the same level as grain, *i.e.* to something below the pre-war level. The milk market is full to overflowing, and manufactured dairy products cannot be relied upon to offer a profitable outlet for the surplus. In fact, at present the farmer whose interests are mainly in stock is probably losing money more rapidly than the man who is concerned chiefly with market crops.

If we consider our position as live-stock producers, compared to that of our chief competitors, such as New Zealand and the Argentine, we have the advantage of considerably better net returns for our products. With cheap manures and modern methods of pasture management we can produce summer keep cheaply enough. Our great disadvantage is our comparatively long winter, with the consequent high cost of growing winter food, of hand feeding, and of dealing with dung; it is here that we must look for new and cheaper methods.

The decline in our arable acreage and the increase of grass are already causing a maladjustment between the various sections of the industry. There is a glut of summer milk, and a glut of grass-fed beef and lamb in autumn. The cost of store cattle in spring is too high in relation to the price of beef in autumn. If we should see any considerable extension of mechanised corn growing in place of the old combination of grain growing with winter feeding, this trouble will be aggravated, with the inevitable result of making the country still more dependent on supplies of foreign meat. If the position of home-fed meat in the urban market is to be maintained or improved, it is necessary that regular supplies of level quality should be on offer throughout the year, an achievement that will be impossible without the necessary supplies of winter food. Yet the traditional system of arable farming combined with winter feeding of stock is far too costly in labour in relation to the present level of prices.

Mechanisation has as its primary object the reduction of labour costs. In order to achieve this object it is usually necessary to adopt larger units. Each department of the farm needs expensive machinery in order to reduce appreciably the labour staff, and the heavy capitalisation entailed can be made economic only on a sufficiently large area. At the present time, there is still too little experience to put this into exact figures, but within the limitations of the machines now upon the market it would appear, for instance, that the minimum size for the fully mechanised dairy herd is somewhere about 60 cows; that the minimum

area of grain for the combine harvester is about 250 acres; that the minimum area for employment of fully mechanised hay-making equipment is from 150 to 200 acres. Except then on very large farms, supposing that tenants' capital is to remain more or less as it is now, and that there is no very sudden alteration in the prices of machinery, it is inevitable that mechanisation will necessitate, to some degree, the specialisation of individual farms. No longer will it be possible to rely on seasonal labour nor to employ a large labour staff all the year round by relying on small areas of various crops whose seasonal labour demands are complementary, whose mechanisation is impossible, and whose costs of production are out of all relation to their food values. But if our home-killed meat supply is to be maintained in quality and quantity from January to December, the supply of winter stock food will still be a necessity, and it seems almost unavoidable that the arable farmer will still have to be the producer of winter meat supplies. How far can this be possible, and how far can this form of live-stock farming be mechanised with the same degree of efficiency and success that dairying, egg production, and pig farming have already been mechanised?

The hay crop, which is the most important source of supply of winter stock food, important to both grass and arable farmers, has for a long time been more mechanised than any other farm crop, and, at the present time, may be completely mechanised under conditions prevailing in Central and South England. Power mowers, side-delivery rakes, and hay sweeps make it possible to cut, make, and stack the hay crop without any horse labour, and with the very minimum of hand labour. Moreover, the tractor works at a greater speed than the horse, thereby making it more possible to "make hay while the sun shines." The capitalisation is not high: hay sweeps may be bought for £25 each, a stacker for £40, and second-hand, high-powered cars which can be bought so cheaply to-day may be very successfully used in combination with the sweeps. Two sweeps can keep a stacker fully employed, and 20 acres a day can be easily handled with a gang of 4 or 5 hands. The combining of the sweep and stacker into one single implement, if it can be made mobile enough, will still further reduce the human labour requirement. Baling the hay direct from the windrow, a system employed extensively in America, has been tried in the Eastern Counties and has met with a fair measure of success, though it is still too early to say whether, in view of the vagaries of our climate, this system will have any important application in this country. Certainly in the cooler and wetter districts it seems unlikely that field baling will become part of the normal routine. In districts where the climate makes it essential to pike or to cock the hay before it can be stacked, the full mechanisation of the crop appears to present greater difficulties, but it is just here that the combined sweep and stacker may come into its own, making it possible to build pikes in one operation. The removal of the pikes to the rick presents no insurmountable

difficulties, either with a mechanically drawn bogie or with a specially designed sweep, stronger but narrower than the one now employed in ordinary hay-making. Naturally there are districts in which none of these systems can be employed, farms which are too small or localities in which the climate makes additional demands. How to reduce costs in the former case is a problem almost without solution, and, in the latter case, if the climate is too severe to make mechanical hay-making possible, it is doubted if hay is the right way of storing winter fodder. Silage is an obvious alternative, and the new A.I.V. process, which is now being closely investigated in this country, holds out considerable promise of improving the whole technique of ensilage.

The other big source of winter fodder, the root break, is a far more difficult problem; the endless hand labour involved is difficult to replace mechanically despite the recent assertions to the contrary in the Press. The costly processes of singling, of hand-hoeing, and of harvesting make all such crops extremely expensive by the time they have been fed to live stock; even when harvesting costs are avoided by penning sheep directly on the crop, costs of production and labour costs in moving the pens are admittedly far too high. In certain favoured districts it may be possible greatly to reduce the costs of growing mangels, swedes, and turnips by the employment of multiple power hoes, and even by some form of mechanical thinning, but this will demand the growing of areas large enough to make the capital outlay economic and also a soil suited to the employment of this type of machinery. In practice little advance has been made in this direction; the root area has consistently declined, and a shortage of winter keep is further aggravating the winter meat situation. If a crop is incapable of being dealt with efficiently by mechanical means it becomes essential to replace it by one which can be. The kales can be grown much more cheaply than roots, and could, without great difficulty, be harvested by machinery such as that used for the maize crop in America. The crop can be grown without the costly singling, mechanical intercultivation is far easier, and weed control less difficult, owing to the smothering effect of the crop. Big yields can be obtained, particularly by the use of large dressings of nitrogenous manures, recent experience having shown that amounts up to 5 and 6 cwt. per acre of such manures as sulphate of ammonia will give economic returns. The most important limitation is the difficulty of storage. Unlike the root crops kale can only be kept standing, and the crop is not perhaps sufficiently winter hardy in many districts. This is a plant breeder's problem, and the quality of hardiness may quite conceivably be improved. Till then silage, as an insurance against frost damage to the kales, may have to be included as a small proportion of the fallow break. No extra capital outlay is involved as the crop can quite easily be handled by the haymaking gear, and can be satisfactorily ensiled in clamp or in pit.

It should, therefore, be possible to use the fallow break to grow

winter stock food by replacing the costly roots with kale, rape, and silage; but if stock is to be winter-fed it must, in some way, deal with the by-product of the cereal crops, the straw. Dung is frequently spoken of by the exponents of continuous corn-growing as an overrated manure, but how is this problem to be solved? The market for straw is already a declining one, and is likely to be more so in the future. The specialised dairy farmer working on the open-air system has no need of the straw of the arable farmer, but if it is a question of using it in the winter production of meat, it is unquestionably cheaper to move the cattle to the straw than the straw to the cattle. However overrated may be the value of dung, it is of far more value to the arable farmer than to the grass farmer, and, unless direct folding of stock is to be practised (which begs the whole question of the disposal of the straw) dung is the inevitable by-product of winter feeding. On suitable land the feeding of hay, oat straw, and forage crops can be carried out on, at. or very near their source of production. The recent experiments with out-wintered cattle at Aberdeen show that there are some advantages in this method of feeding as compared with house feeding. Sheep may also be penned in large blocks on the fodder crops at very little expense. There is no reason, therefore, why the return of the hay and fodder crops to the land should entail any expenditure beyond a modest labour charge and the cost of temporary fencing; but still there remains the difficulty of the straw conversion.

Some land may be capable of being farmed year in, year out, without any organic manure other than the occasional ploughing in of a ley, and on such land the conversion of straw into dung may be wasteful and uneconomic. Under these conditions it may probably be wiser to sell the straw at any price than to go to the expense of dunging the land. But by no means all of the land in the country is of this enviable quality, and the consistent use of nothing but artificials will, on many soils, cause an inevitable decline in fertility. The expense of maintaining fertility by having recourse either to a closely folded arable flock or to the costly dung-cart is prohibitive. The artificial conversion of straw into organic manure by some such process as the Adco method is also no direct solution, since one of the major costs in applying dung is the cost of handling and spreading it. Therefore at the present time, there appears to be no alternative but to cart it out from the yards on to the land. This procedure can, however, be mechanised up to a certain extent, firstly by keeping the stock as near as possible to the land where the dung is actually required, and secondly by spreading with mechanical cart-spreaders.

How far live stock can be included under the mechanised arable farming system is essentially a problem for each individual farm; on some farms they may be completely replaced by artificial manures and by straw selling, on others the mechanisation of the arable land may, in effect, be nothing more than the rationalisation of a relatively unimportant department. But this much is certain,

that if the supply of home-killed meat is to be maintained, winter feeding will still have to go on, and this will have to be done under arable conditions owing to the absence of alternative supplies of bulky fodder. To a considerable extent the out-wintering of cattle and sheep on such economic crops as kale will make it possible to produce winter meat at reduced costs, to do away with or to limit the bare fallow, and also to return directly to the soil the residual values of the hay and fodder crops. The difficulty of finding an economic way of disposing of the straw has yet to be overcome, but it is suggested that the bulk of it may still be economically trodden in yards by cattle if the costs of the other food materials are sufficiently low, if the place at which the dung is made is near enough to the point where it is needed, and if its handling is efficient. As a result of maintaining live stock under arable conditions the fertility of the land will be maintained at a level above the bare requirements of the cereal crops. Potatoes and other saleable crops will still be possible, and home production of meat will be spread more equally over the year.

In order that the system may operate successfully there will have to be enough land under cereals to employ a combine harvester economically and enough under hay to allow for fully mechanised hay-making. A hypothetical farm worked on a five-course rotation of two years' grain, hay, one year's pasture, and a break of potatoes, kale, rape, and silage, would have to run to some 700 acres. With the advent of smaller and cheaper machines it might be possible to come down to 500 acres without serious loss of economy. The farm would then consist essentially of three departments. First would be the cereal crops, cultivated and sown by tractor and harvested by combine, the straw being swept up and stacked in a corner of the field where it grew. Secondly, the hay crop would be manipulated with the machinery described and stacked on the field, or possibly baled off the ground. Thirdly, there will be the winter forage crops and the stock which are maintained upon these; sheep, out-wintering, and some house-fed cattle—or perhaps cattle that are kept out of doors in the early part of the winter and brought in to finish.

To sum up, our argument is that if anything like the present relationship between wages and agricultural prices is to be maintained, some considerable degree of mechanisation is necessary. The output of our farms at current prices cannot maintain the present number of workers at their present wage. Mechanisation, on farms of moderate size, must involve some measure of specialisation. But it does not follow that a complete revolution of arable farming systems is necessary or desirable. It would seem that the line to follow is to mechanise those departments which lend themselves to the process and drastically to cut down those operations, like turnip-growing and dung-carting, which make heavy demands upon horse and manual labour.

LAND SETTLEMENT IN SCOTLAND.—II.

Results.—In the Highlands and Islands, 770,000 acres of land have been made available since 1886 for new holdings and for enlargement of existing holdings, to the great relief of congestion in various districts. In the island of Skye alone about one-half of the total area of 429,000 acres has been subdivided for applicants ; while in Lewis, where congestion has always been bad, and where a special provision of the 1911 Act made the maximum limits for landholders' holdings £30 of rental or 30 acres instead of £50 or 50 acres as elsewhere, nearly 59,000 acres have been opened up for the inhabitants. The Department are in course of completing one scheme comprising 3,000 acres for the enlargement of 88 existing landholders' holdings, and have in hand proposals for subdividing a further area of 1,600 acres into 11 new holdings. Only a small area of land is now available in the island. In Harris, which is also a badly congested area, 11 schemes in all, embracing about 20,000 acres, have been projected, the most recent being that of Luskentyre Deer Forest, which the Department acquired under a compulsory Order for subdivision into 10 holdings, each with a share in common pasture and a club sheep stock. To relieve congestion, 68 families were a few years ago taken out of Harris to the scheme of Talisker in Skye, where they are now living under conditions which Harris could not offer them. Further examples of what has been done are too numerous to relate here, but it can be claimed without question that the combination of security of tenure with a fair rent conferred on crofters by the fundamental Act of 1886, and the subsequent operations under succeeding Acts, have greatly improved living conditions in the Highlands and Islands.

The small size of the holdings in the crofting districts is often a subject of comment. The necessity for the township system has already been explained. To subdivide the area held by a township into economic self-contained holdings for a fraction of the population of the township is out of the question, and the alternative is to secure any land that may be available for the purpose of enlarging the common grazings, and thus benefiting the whole community.

In the rest of Scotland, land settlement is on a different footing. Here it is a case of taking over large arable subjects and subdividing them into holdings capable of being made self-supporting, and varying in size and type from the mixed arable, live stock, or dairy holdings to the smaller poultry, pig, or market-garden holdings. The Department generally endeavour to secure land in proximity to good marketing centres, especially where there is a demand for the smaller types of holdings. The Lowland small holdings established by the Department are rarely of an area less than 5 acres, the upper limits being 50 acres or £50 of rental, as prescribed by the Acts, and the predominant type being between 5 and 10 acres.

Access to 46,000 acres of land in the Lowlands has so far been provided for 1,717 applicants, and of that area 33,500 acres, representing no fewer than 50 separate estates, are owned by the Department. These estates are diverse in size and character, ranging from the single farm to the estate which before subdivision embraced perhaps 20 farms. On the estates of Terregles and Gretna in the south-west, extending respectively to over 2,300 and 4,600 acres, and composed originally of 17 and 22 farms, colonies of small holdings, numbering in the one case 73, and in the other 115, have now been established for ten years; and having regard to the increase in food production, the larger population maintained on the estates, and the standard of living enjoyed by the holders and their dependants, there can be no question as to the general success of these settlements.

An important feature of land settlement is the contribution which it makes towards a solution of the housing problem in rural districts. It became apparent within a few years after the passing of the 1886 Act that, as a direct result of the rights of security and compensation conferred on crofters, vast improvements in housing conditions in the Highlands and Islands had been effected. The prevailing "black" house—a rude structure of stone and clay with a thatched roof in which the crofter's family and his stock were housed—began to disappear, and with the aid of loans made by the Department the revolution in housing conditions has spread so that to-day only a few of the primitive "black" houses remain. In their places stand well-constructed, hygienic, stone and slated cottages and separate steadings built mainly by the labour of the crofter, the cost of materials being met from loans advanced by the Department.

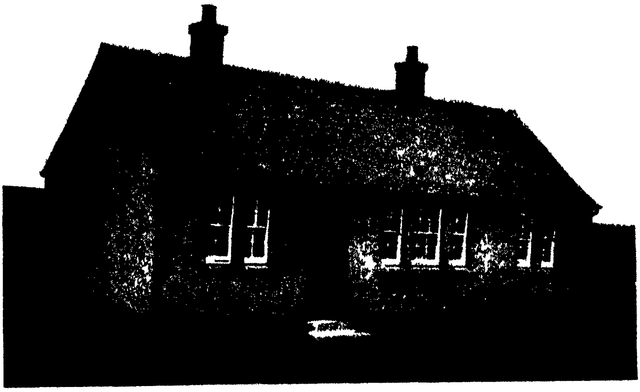
In rural areas in the Lowlands, in contrast to urban areas, comparatively little reconditioning has been carried out under the Housing Acts. Much has, however, been effected under land settlement administration. The poorly equipped farm when taken over has its buildings repaired and adapted, and its other equipment renovated, and tidy, up-to-date cottages and new byres and steadings appear on the holdings formed.

In the Lowlands as distinct from the crofting districts, building works are put out to tender on the market, there being little, if any, traditional aptitude for building among the Lowland peasantry. The new houses erected on small holdings generally conform to standard plans designed by the Department for particular types of holdings. New steadings, varying from the store accommodation suitable for the small poultry or market garden holding to the various equipment necessary for the larger-sized holdings of the dairying and stock-raising types, are also erected on the holdings created. In order to make the funds serve the greatest possible number of applicants, the Department's policy in the provision of buildings and equipment has been to provide each holder with only the minimum accommodation necessary to enable him to carry on the cultivation of his holding.

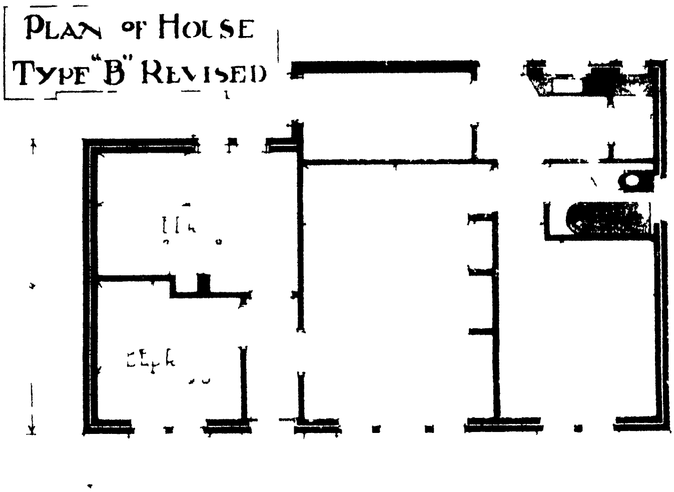
"Black" house on croft in the Island of Skye

New house of three rooms erected on the same croft with aid of loan made by Department

New house of four rooms erected on croft in Lewis by aid of loan from Department, in place of "black" house



Standard four roomed house erected on small holdings in the Lowlands



Plan of above house

Another standard four roomed house provided in the Lowland counties

The total numbers of houses and steadings which the Department have erected or improved during the past twenty years under their land-settlement and crofter-housing schemes are 3,936 and 1,929 respectively, and the numbers in course of erection or not yet begun, but to whose provision the Department are already committed, are 1,137 houses and 392 steadings, making altogether 5,073 houses and 2,320 steadings which the Department will have erected, adapted, and improved on completion of the programme to which they are committed. The estimated initial cost of this housing provision is about £1,690,000, of which approximately £1,345,000 was spent by 31st March 1932. The Department's activities have thus provided work for a large number of men in the building trades.

Social and Economic Benefits.—The following tables relating to two groups of seven arable and four pastoral farms repectively, on which holders were settled in the five years following the war, are interesting as illustrating the changes resulting from the subdivision of the farms into small holdings.

(1) *Seven Arable Farms.*

	Prior to Settlement.	In 1931.
Total population	294	558
Acreage under crops other than hay and grass	2,050	1,568
Acreage under hay and grass	5,589	5,585
Total acreage	7,639 [1]	7,153 [1]
Number of Horses	131	197
Do. Dairy Cattle	159	520
Do. Cattle other than Dairy	426	621
Do. Sheep	2,989	2,339
Do. Lambs	1,277	2,093
Do. Pigs	99	172
Do. Poultry	1,236	14,642

(2) *Four Pastoral Farms.*

Total population	97	660
Acreage under crops other than hay and grass	107	787
Acreage under hay and grass	63	1,447
Acreage under grazing	33,176	29,002
Total Acreage	33,346 [1]	31,236 [1]
Number of Horses	22	118
Do. Dairy Cattle	34	358
Do. Cattle other than Dairy	405	701
Do. Sheep	9,163	7,885
Do. Pigs	8	26
Do. Poultry	300	3,287

[1] The difference in these totals is caused by the sale or exclusion from the Department's schemes of certain areas.

The most striking feature of these changes is the trebling of the total population on the eleven farms concerned; and in view of the gradual depopulation of the countryside generally, this feature of land settlement is one of cardinal importance. In 1931, the number of workers on the land fell by over 3,800, and similar reductions have been occurring for many years—a process of attrition which the nation cannot afford to regard with complacency.

Some factors in the life of a small holder can be measured, but the *imponderabilia* are equally, perhaps more important. Small holders are assured of independence; they have greater responsibility; their outlook is widened; they have plenty of work and are guaranteed the full enjoyment of the fruits of their labour; with security in their homes, they enjoy facilities for the uninterrupted education of their children, and all live under the healthiest conditions.

The Department have no lack of evidence as to outstanding successes amongst the holders settled—men who began in a small way and have gradually built up out of profits considerable businesses. Failures have been comparatively few, and have occurred chiefly in the class of ex-service applicants settled under Government pledge in the post-war period, who, being mostly hurriedly trained in agriculture and subsidised for stock and equipment, could not stand up against the heavy fall in agricultural prices which occurred before they were properly established. Nine-tenths of the unsuccessful holders were settled between 1919 and 1924, the number amongst those settled in pre-war days and subsequent to 1924 being negligible. But the value of land settlement is to be judged, not by the conspicuous successes nor by the few who have failed, but by those holders—a very large proportion of the total settled—who are making a living under the heathiest conditions for themselves and their families.

Land Settlement in Other Countries.—In most countries of the world the breaking up of large agricultural units into smaller ones is now regarded as an essential policy. It is generally recognised that this process cannot be carried out without cost, but the policy of closer settlement has been adopted in the belief that the cost to the taxpayer is more than recompensed by the retention of a larger rural population and by the more intensive cultivation which follows. Most Western European countries (for example, France, Germany, Denmark, Belgium, and Holland) have expanded or maintained their agricultural population by the extensive creation of small holdings, and since the war they have increased rather than curtailed their expenditure in this direction. In Germany, from 1891 to 1910, over 32,000 new holdings were created on over a million acres, while between 1919 and 1923 the new settlements made embraced over 230,000 acres. In Denmark—a country which, having no colonies to absorb her surplus population, has had a policy of intensive land settlement forced upon her—roughly 150,000 families were settled during the nineteenth century,

about 80,000 being established on self-supporting small farms; while between 1900 and 1930, 19,000 additional small holdings, averaging about 17 acres in size, were formed. Although only half the size of Scotland, Denmark has three times the number of holdings, those over 300 acres representing 0·6 per cent. of the total as compared with 23 per cent. in Scotland. In creating these holdings the State has assumed considerable financial burdens, but holds to-day the position of accounting for one-quarter of the world's international butter trade and more than one-half of the bacon trade.

That land settlement is to the highest degree beneficial cannot seriously be controverted. The arresting of the exodus to the towns of the best types of rural life, the maintenance of a healthy stock for the supply of virile recruits for agriculture, industry, and commerce at home, and for the building up of the Dominions overseas, are surely advantages the value of which cannot be too highly assessed.

THE POSITION AND PROSPECTS OF THE POULTRY INDUSTRY IN SCOTLAND.

W. H. SENIOR, M.Sc., B.Sc. (Agric.).

THE Agricultural Statistics for 1930 show that in that year the total number of poultry in Scotland (including ducks, geese, and turkeys) was 6,664,000 birds, of which 6,317,000 were fowls. Statistics are available for 1913, 1921, 1922, and from 1926 onwards to the present time. Throughout the whole of the period since 1913 there has been a continuous increase in number.

Numbers of Poultry in Scotland.

Year.	Fowls.	Total (including Ducks, Geese, Turkeys).	Per cent. increase over previous year.
1913	4,054,000	4,341,000	..
..	..	..	..
1921	4,216,000	4,549,000	..
1922	4,276,000	4,608,000	..
..	..	..	..
1926	5,015,000	5,428,000	..
1927	5,320,000	5,675,000	4
1928	5,424,000	5,763,000	2
1929	5,643,000	5,971,000	4
1930	6,317,000	6,664,000	12
1931	7,078,000	7,424,000	11

There were in 1930 56 per cent. more birds in Scotland than in 1913, 54 per cent. more than in 1921, and 23 per cent. more than in 1926. This is indicative of the rapidity of the expansion in this branch of the agricultural industry in recent years. During the last five years, the numbers have been increasing at a

progressively faster rate. The increase in numbers in 1930 over those of 1929 was 12 per cent. The figures for 1931, which are now available, show a further increase of 11 per cent. in the number of poultry over the year 1930. This expansion, however, has been by no means general over the whole country. In most of the counties north and west of Aberdeen, namely Banff, Nairn, Argyll, Ross, and Zetland, the increase in numbers in 1930 over those in 1926 has been negligible, while in Inverness, Sutherland, and Caithness there has been an actual decrease. This is most marked in the case of Sutherland, which in 1930 had 20 per cent. less poultry than in 1926. Peebles in the south is the only other county to show a decrease during these five years. In all other counties increases have been general, ranging in a few cases to more than 40 per cent. of the numbers in 1926. The degree of increase would seem to be related fairly closely to the distribution of urban population. Those counties with the lowest percentages of urban population to total population showed decreases or very small increases, while the counties with the heaviest percentages of urban population were those where the increase in poultry stocks had been greatest.

Percentage Increase or Decrease in the numbers of Poultry in each County in Scotland between 1926 *and* 1930.

Decreases.	Increases.				
0 to 20 per cent.	0 to 10 per cent	10 to 20 per cent.	20 to 30 per cent.	30 to 40 per cent.	Over 40 per cent.
Inverness	Banff	Kinross	Renfrew	Ayr	Clackmannan
Sutherland	Nairn	Berwick	Roxburgh	Fife	Midlothian
Caithness	Argyll	Bute	Lanark	Dunbarton	West Lothian
Peebles	Ross	Kirkcudbright	Dumfries	Stirling	.
..	Zetland	Orkney	Angus	East Lothian	..
..	..	Wigtown	Perth	..	..
..	..	Selkirk	Aberdeen	.	..
..	..	Moray	Kincardine	..	..

In Midlothian the increase has been phenomenal, there being three and a half times as many birds in the county in 1930 as in 1926. This is partly due to the development of one large farm going in for egg production on a "factory" scale. However, even when this is left out, the increase is proportionately much greater than in any other county. The two other counties with the next heaviest increases were Clackmannan, with 50 per cent., and West Lothian, with 45 per cent.

The position poultry occupy in the agricultural industry is revealed if reference is made to the Report on the Agricultural Output of Scotland, 1925.[1] Unfortunately the results of the 1931 Census of Production are not yet available, to give more recent figures.

[1] Cmd. 3191.

Estimated Value of Produce sold off Farms and other Holdings in Scotland in 1925 and 1908.

	1925.	1908.
Poultry and eggs [1]	£2,230,000	£650,000
Total of all produce	£48,660,000	£26,450,000
Per cent. of total	4·6	2·5

In 1925 the total value of poultry and eggs produced amounted to about 2¼ million pounds, or 4·6 per cent. of the total value of all agricultural produce. In 1908 poultry and eggs accounted for only 2·5 per cent. of the total. There is evidence here of an increase in the relative importance of poultry produce as compared with other types of agricultural produce. The productivity of the hen has also been increasing. In 1908 the estimated annual production of eggs in Great Britain was 72 per laying hen. In 1913, for Scotland, it was 84, in 1925 it was 100, while the figure obtained in the more recent census of production is 118. This is most striking progress, but an average of rather more than 2 eggs per week from each laying hen does not suggest that the limit of improvement has been reached.

Progress in England and Wales has been on similar lines to that in Scotland. In 1908 the estimated value of poultry and eggs sold off farms was 3·4 per cent. of the total value of all agricultural produce, and in 1925 it was 6·7 per cent. of the total.[2] The relative importance of poultry is somewhat greater than it is in Scotland. Scotland is essentially a stock producing and feeding country, its climate and topography being more favourable to the breeding and feeding of stock than to arable cultivation over the greater part of the country. Moreover, its population is sparser and its industries less widely diffused than in England. The existence of a considerable export trade in both beef and mutton in contrast with the absence of any such export from England, and the greater dependence of that country on imported supplies, emphasises the fact that the chief value of Scottish products lies in meat. It is not surprising, therefore, that poultry-keeping is of relatively less importance north of the Border.

The total value of imports of poultry produce into the United Kingdom during 1931 was almost £20,000,000, whereas the value of poultry production in Great Britain in 1925 was about £17,000,000, and of this the Scottish contribution was only £2,230,000. The increased importance of poultry in recent years would not justify the deduction that poultry-keeping as a specialised business has reached any considerable degree of development in Scotland. It is still true, looking at Scotland as a whole, that poultry are kept mainly as an adjunct, and not a very important adjunct, of the general farm business.

[1] This includes the value of poultry and eggs estimated to have been consumed in the farmhouse.

[2] *The Agricultural Output of England and Wales*, 1925, Cmd. 2815.

Poultry are rather similar to pigs, in that they utilise as food a great deal of what would otherwise be waste. They pick up quantities of food on the stubbles and fields and in the farmyard, and though this method of feeding is by no means scientific or likely to lead to very high laying records, nevertheless, from the general farmer's point of view, it is a profitable enterprise. If his egg production is low compared with what it might be, his expenditure on foods for the poultry is also low, so that on balance he is in pocket. There is evidence that rather more attention is being given to poultry-keeping on the general farm by the introduction of better laying strains and more careful control of feeding and housing, but it still remains true that their value to the farmer lies in their utilisation of waste. He does not usually have to provide labour for them out of his farm staff. The labour required to attend to them is usually provided by the part-time work of a member of the family.

Of the total number of birds in Scotland, 92 per cent. are kept on farms of a more general character. Of these, only 21 per cent. are in flocks of 300 birds or more, and here they may receive attention as a section of the farm having some commercial importance. The remaining 71 per cent. are in flocks of less than 300 birds.

Only 8 per cent. therefore of the total poultry in Scotland are to be found on farms which have specialised in poultry-keeping. This apparent lack of development of specialisation merits consideration. Again, poultry would seem to be in a similar position to pigs. The development of specialised pig-farming is on just such a modest scale, and is usually to be found in districts where waste from hotels, restaurants, etc., or industrial by-products are available.

The distribution of these specialised holdings varies greatly county by county. Out of the 33 counties in Scotland, 19, including those north of the Grampian escarpment, and the Border counties, with the exception of Berwick, have usually less than 10 per cent. of their poultry on specialised holdings. This is no doubt explained by the comparative absence of centres of urban population of any size within their borders or within reasonable distance. The following counties have from 10 per cent. to 20 per cent. of their poultry on holdings of this type :—

Clackmannan,	Renfrew,	Dunbarton,	Berwick,	Angus,
Ayr,	Fife,	Stirling,	Lanark,	Perth.

In these counties both large and small centres of population are fairly well distributed, and markets for poultry produce are near at hand.

The following counties have more than 20 per cent. of their poultry on specialised holdings :—

West Lothian,	Kinross,
Peebles,	Midlothian.

While the greatest development of specialised poultry-farming is thus seen to be related broadly to the distribution of urban population, it is probable that the more highly developed arable cultivation practised in the east places the poultry farmer there in a position to obtain cereal and other by-products more advantageously than can his fellow in the west.

On small holdings generally, poultry-keeping is not very highly specialised. Out of a total of 1,051 small holdings in eleven counties in the South of Scotland in 1927, 148 had no poultry at all, 766 had flocks of 300 birds or less, 81 had flocks of from 300 to 600 birds, and only 56 had flocks of over 600 birds.

In Midlothian in 1931 there were only 25 specialised commercial poultry holdings carrying more than 500 birds. In West Lothian there were 13, and in East Lothian 10. In some recent work on the statistical classification of farms in Berwick, Roxburgh, and Selkirk, it was found that while the average number of poultry carried on the larger farms was 153, the average number carried on the small holdings was only 123, and this average included the specialist poultry farmers.

Whilst it is true to say that almost all specialised poultry holdings, as found in Scotland, are dependent on commercial egg production for the greater part of their income, it is also true that growing importance is being attached to the breeding of stock for sale as day-old chicks and sittings of eggs. Most of the poultry farmers who have very generously placed their accounts at the disposal of the Department have to a greater or less degree developed a trade in breeding stock. A combination of both enterprises seems to be necessary to maintain a continuous income throughout the year. Those poultry farmers who are concerned only with the sale of commercial eggs and table birds would appear to be situated on the outskirts of towns, with the possibility of the development of a retail trade.

The greater proportion of eggs for table consumption produced in Scotland undoubtedly comes from the general farms, which most frequently rely upon their own stock for sittings, and rarely attempt to run poultry as a major department of the farm.

The accounting results of rather more than 150 farms of various types, situated in various parts of Scotland, which were received at the Department in the course of the Investigation into the Profitableness of Farming, have been used in assessing the importance of the poultry enterprise in the general farm business, and in showing how that importance varies in different parts of the country. The accounts used relate to the year 1930-31. On the average they cover the last quarter of 1930 and the first three quarters of 1931. Although it is not yet possible to claim that these farms whose accounts are dealt with are strictly representative, it is thought that they are broadly typical of prevailing conditions.

Individual variations of some magnitude do occur between farm and farm, but the averages for the various groups broadly indicate the position. In no group of farms were receipts from poultry and eggs more than 7½ per cent. of the total receipts. In the north-east area on four groups of farms engaged mainly in the rearing and feeding of cattle, and one group of dairy farms, the average head of poultry carried ranged from a little over 100 per farm to as many as 400. The percentages of total receipts ranged from 1 per cent. to 7 per cent., and the gross amount of income from poultry was, with the exception of one group, where it was £168, between £30 and £60.

In the groups of arable farms in the central eastern counties and in the groups of semi-arable sheep farms in the Borders, the average receipts from poultry were never more than 1 per cent. of the total, though as these farms are much larger enterprises, the gross income from poultry ranged from £1 to £40 per farm. In the east the average number of birds carried varied from 20 to 100 birds, and in the Borders from 100 to 150 birds per farm.

The cheese-selling farms of the south-west averaged about 140 birds per farm, which provided about £160 of income or about 3 per cent. of the total. The general milk-selling farms, however, carried rather more than 200 head of poultry on the average, and these gave about £152 of receipts or rather more than 7 per cent. of the total. In some cases it was noted that sales of breeding stock were taking place, indicative of new attention being given to this enterprise.

The accounting data available do not permit of the apportionment of "prime costs" to particular departments of the farm, and consequently it is not possible to assess what surplus is contributed by the poultry enterprise towards meeting the general farm overheads. The data do show, however, that poultry in general farming form one of the minor departments. It is an enterprise of little or no importance on the arable farms of the east and the semi-arable sheep farms of the Borders, but somewhat more important on the smaller dairy farms in the south-west and the cattle-rearing and feeding farms of the north-east. In the two latter areas family farming is the rule, and the heavier development of poultry-keeping on these farms is no doubt largely due to this. To account for the relatively small development of poultry-keeping as a separate department of the more general farms, the returns from specialised poultry-keeping must be examined.

In the early part of this year a brief survey of specialised poultry-farming was carried out, with a view to ascertaining the profitableness or otherwise of this type of farming as distinct from general farming. The accounts obtained refer to holdings situated mainly in the East of Scotland, and were obtained partly by personal visits and partly by post.

The accounts which it was found possible to complete

numbered twenty-nine, and referred to the year 1930-31. All the holdings were essentially family holdings. The dates of closing the accounts varied, but on the average the period covered was the last quarter of 1930, and the first three quarters of 1931. All these holdings were engaged in commercial egg-production, and the majority also in the breeding of stock for sale, as hatching eggs and chicks, in varying proportions. In some cases accounts were received for the previous year. In arriving at a profit on the year's working no charge has been made for interest on capital or for family labour.

The holdings ranged in size from half an acre up to 16 acres. The number of birds carried varied roughly with the size of the holding, and ranged from 100 birds up to 1,700 birds. The average number of birds on these 29 holdings was 576. It is difficult to say whether this size of flock is larger or smaller than would be found on the majority of specialised poultry holdings in Scotland. It is probably larger, for in Midlothian, for example, rather more than half of such holdings have from 100 to 500 birds only, and whilst larger flocks on other holdings might bring the average to upwards of 500, the most common unit will have less than 500 birds. In 1930-31 the capital invested in birds and equipment varied from £70 to as much as £1,300, but the average amounted to £477 per holding, which, divided by the average number of birds, gives a figure of rather less than £1 per bird.

The accounts of every holding showed a profit, the average being £208 per holding, and the range being from £50 to £420. This average profit of £208 per holding has to cover interest on capital and all the unpaid family labour. It is possibly rather a conservative figure, since the value of eggs and poultry consumed in the house was estimated in most cases at an amount lower than would be expected to obtain, and the rent charged will generally have covered the annual value of the holder's cottage, which should properly be assessed and added to the farm income. In a few cases also the rent-charge includes the repayment by instalments of loans from the Department.

Of the 29 holdings—

7	made	profits	ranging	up to £100		
7	,,	,,	,,	from £100	to	£200
8	,,	,,	,,	,, 200	,,	300
7	,,	,,	,,	,, 300	,,	420

On the whole the larger total profits were associated with the bigger enterprises measured by the number of birds carried and the capital invested, and the smaller profits with the smaller enterprises.

Twelve holdings, with an average of less than 400 birds per holding, and an average investment in birds and equipment of £227, had an average profit of £114. Twelve holdings, with between 400 and 800 birds, and an investment of £540 per holding, had an average profit of £239. The remaining five holdings,

with flocks of more than 800 birds, had an average investment of £928 and an average profit of £399. This does not imply that profit per bird was higher in the larger enterprises.

Group of holdings.	No of holdings.	Average investment, birds and equipment.	Average profit per holding.	Average profit per bird.
		£	£	s. D.
Up to 400 birds .	12	227	114	10 0
400 to 800 birds .	12	540	239	7 10
Over 800 birds .	5	928	399	5 5

The average profit per bird amounted to 7s. 2d. over all the holdings. On those holdings with the twelve smallest flocks, however, it was 10s. per bird; on the next group of holdings, with from 400 to 800 birds, it averaged 7s. 10d., and on the five holdings with the largest flocks, the average was 5s. 5d.

The labour incomes of the holders are the main test of the economic condition of these specialised enterprises. After allowing 5 per cent. on the investment in birds and equipment, the average labour income amounted to £184, and ranged from £40 to as high as £380. If the number of people who both work on the holdings and share in the proceeds is considered, the average labour income per person was £155, which is probably above the average return on specialised poultry holdings for the whole country. On the average the larger enterprises provided the greatest labour incomes, but increase in the labour income is much less rapid than the increase in size of the enterprise as measured by the number of birds carried. In interpreting these returns, it may be necessary to bear in mind that in some cases poultry-keepers are persons disabled for full-time manual employment, and may be in receipt of pensions, or they may not rely upon their holdings as their only source of income.

Accounts for the earlier year 1929-30 gave rather better results, and the indications are that 1929-30 was the best year poultry-keepers have had for some considerable period. 1930-31 was not so good, neither was 1928-29, and 1927-28 was still less favourable

At the present time it would appear that current prices of eggs and foodstuffs will leave a still narrower margin for 1931-32 than in 1930-31. Prices of eggs slumped badly in December last, and have remained low ever since, though it is reasonable to expect that after July there will be some seasonal rise in prices. On the other hand prices of foodstuffs have risen somewhat during the last six months.

To sum up, therefore, while there is room for an all-round improvement in the quality of stock and in the methods of feeding and handling, there may be no strong inducement for the general farmer to develop this enterprise beyond the point up to which family labour is sufficient for attention and management, to the stage where it would be necessary to employ special labour. The development of specialist poultry holdings would seem to

be most profitable in two particular directions: firstly, in commercial egg production, where a situation near to a consuming centre presents itself, coupled possibly with the retailing of eggs, and secondly, the development, in less favourable situations as regards consuming centres, of a more speculative trade in breeding stock.

In conclusion, the writer would like to take this opportunity of saying that all the approaches to poultry farmers met with the most generous treatment. Acknowledgments are also due to many of the Poultry Instructresses for introductions to a number of the holders, and to Dr Imper, Advisory Economist at the North of Scotland College of Agriculture, for contributing a number of accounts.

THE BIOLOGIST ON THE FARM.
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Professor Sir J. ARTHUR THOMSON, M.A., LL.D.,

Emeritus Professor of Natural History in the University of Aberdeen.

Persistence of Life in Seeds.—We have several times referred to the question of the length of time that vitality may linger in inactive seeds. The question refuses to be put to sleep because it is a relative one, and because good instances of long latency are of frequent recurrence. While it is probably true that genuine "mummy wheat" never sprouts, though what is *called* "mummy wheat" often does, there is no doubt that seeds may occasionally lie latent for a century.

A good recent case is vouched for by Sir Arthur Hill, the Director of Kew. It concerns some lotus seeds (*Nelumbium*) from the Manchurian peat, which germinated at the Gardens after lying latent for 120 years. Robert Brown germinated a seed of the same plant which had been in the British Museum for 150 years, and other cases have been carefully recorded. After the fruit of the lotus or water-lily rots and bursts, it is the habit of the seeds to lie latent for a time in the mud at the foot of the pool, and it may be that this is life-saving in situations where drying up of the pools is of common recurrence.

Professor E. J. Salisbury writes to *The Times* from Herts, calling attention to the re-assertion of the Blue Pimpernel after many years of latency, and many a farmer has noticed similar cases. "The site was a two-acre meadow which, though under hay for at least 60 years, bore unmistakable signs of having been once under the plough. There is indeed little doubt that it is one of the many arable fields which were laid down to grass at the end of the Napoleonic Wars. In several places where the turf was stripped off various cornfield weeds appeared, and notably plants of the Blue Pimpernel, a plant now exceedingly

rare in Hertfordshire." The plant did not appear except where the turf was stripped, and the strain was exceptionally dark-flowered, as compared with that still found as a casual in the county. Thus it is likely that the seeds had remained dormant for more than a century, since the area in question was cornland. Seeds that have this power of retaining vitality without sprouting may secure the survival of the species in untoward conditions, such as drought. But this does not explain what the strange state of latency actually implies. What is the true inwardness of the state when the protoplasm remains inactive, yet does not disintegrate.

In a recent letter to *The Times*, Messrs Sutton, the well-known seedsmen, recall the fact that there are only some plants which have this quality of lying low. It depends on a combination of qualities, and thus, in the struggle for existence, only certain kinds of plants would survive when dormancy was indispensable. Thus smallness of seeds is sometimes of great advantage in reducing the area of vulnerable surface; hardness of seed-envelope may be very useful in withstanding bacteria: or there may be protective oils in the seed substance that are of great value in retaining vitality. Messrs Sutton report fifty years survival for black mustard and curled dock, twenty-three years for charlock, poppy, and fumitory.

It will be understood that upheaving of the soil, whether by bomb or plough, is not necessary to bring about the revivification of dormant seeds. Let us refer to a common instance. Seeds dropped or carried into dense vegetation, *e.g.* on the roadside skirting a wood, may fall into crevices and be shut off from light and rain by the close-growing plants well-adapted for such a situation. But some change, such as a piling of cut timber, may kill off these normally present plants, and when the timber is eventually removed there comes to be a sprouting of the dormant seeds, now relatively accessible to radiation and moisture. They reassert themselves in the cleared space, though there has been no delving.

Scented Musk again.—Some years ago there was a disappearance of the scented musk, *Mimulus moschatus*, which used to be common in our childhood. The scented variety waned and became rare, and for many years now there has been no specimen to be obtained. It may be that the variety ceased to produce the characteristic scented substance, or that the substance—some by-product of the plant's chemical routine or metabolism—was produced without having any scent; we do not know.

It is interesting, therefore, to notice that in the 1931 Report of the Provincial Museum of Victoria, British Columbia, it is recorded that a scented specimen was received from North-East Point, Texada. It had a strong musky odour, which attracted the collector. So the peculiarity has either persisted in that corner or has reasserted itself afresh.

The Rôle of Magnesium.—About a score of chemical elements

occur in combination in the living body, and most of them are of relatively common occurrence in the ordinary surroundings. This is familiar in the case of carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, calcium, and so on. But apart from the "big four" (carbon, hydrogen, oxygen, and nitrogen), the compounded elements are present in small quantities in the living body, and some of them are present only in minimal amount. One of those that is generally present and not in very small quantity is magnesium, but there is little certainty in regard to its physiological rôle in animals.

Magnesium is well represented in the bones and in the blood of mammals, but what it precisely does is a puzzle. Some recent researches by E. V. M'Collum and Elsa Orent, at Johns Hopkins University, are very striking. Rats were fed on magnesium-free diet (which is not readily arrived at), and soon showed strange symptoms. Within three days there was a dilation of the blood-vessels on exposed surfaces, which subsequently subsided. Within ten days there set in a remarkable apprehensiveness, unexpected in the usually placid laboratory rats. They became strangely nervous, starting at shadows, whirling round in circles, collapsing and usually dying. Those that survived came to show extreme decalcification of the skeleton ; and this eventually proved fatal. The condition was countered and cured at any stage by adding magnesium to the diet. Thus we may say that magnesium is essential to health and survival, though its precise rôle remains a riddle.

The same investigators have made up with great difficulty a diet free from manganese, an element which is present only in minute traces in the body. In milk there is so little that rats and mice restricted to a milk diet show some of the symptoms induced by a manganese-free diet. Without manganese males become sterile, and litters of females are frequently still-born, or, if living, are not suckled. Perhaps manganese, like vitamin E, is essential for the functioning of the anterior pituitary body.

There is no doubt that further researches will lead us to attach more and more importance to some at least of those elements which are present in very small quantities. Iron is needed for the formation of the red blood pigment hæmoglobin, but there is hardly any iron in milk. If iron be added anæmia is not prevented, for the presence of copper is also necessary. Yet copper is present only in traces in the body, and not at all in the hæmoglobin !

Can Bats Rise from the Ground.—It is still held by many that bats cannot rise from the flat ground, but the belief is erroneous. The belief was confuted by Gilbert White's observations in the eighteenth century, but there have been recent confirmations. Thus Mr C. E. Johnson describes how an old female Red Bat (*Lasiurus borealis*) alighted on the floor and rose from it again as easily as a bird. The same fact has been recently recorded for two other bats of different genera ; so the error should be buried.

It may of course happen that a bat is found lying on the ground unable to rise ; but that proves nothing.

Influence of Moonlight.—Not much is known as to the influence of moonlight on living creatures, though lunar periodicity has been observed in certain cases like the swarming of the palolo worm. There are some recent observations of interest by Elizabeth S. Semmens, who found that the starch disappeared from the parts of a vine-leaf sharply shadowed by another leaf in bright moonlight (ninth day, near the time of maximum polarisation). Similar results have been recorded for spinach and tropæolum (after covering parts of the leaf with cardboard or tinfoil) : hydrolysis occurs in polarising light. The disappearance of the starch is not seen at full moon, as the light is not then polarised.

Crossing Wolf and Dingo.—The wild dog or dingo of Australia, now becoming scarce, was present there, as fossilised remains show, before historical colonisation began. Some authorities maintain that it is our domestic dog gone wild or feral : others trace it to Studer's stone-age dog, *Canis putiatini*, which was ancestral to the European domestic dog ; others regard it as a descendant of an Indian wolf. We do not know. There are, however, records of crosses between the domesticated dogs of the settlers and the dingos, and there has recently been a pairing between a male European wolf and a female Australian dingo in the Zoological Garden at Adelaide. The resulting hybrids, six in number, were all females, and with more resemblance to the dingo than to the wolf. It may be noted here that fertile crossing of Alsatian dog and wolf has occurred several times in Britain.

Study of a Leg of Mutton.—The more fastidious people are in regard to their food, the better that food will become. For more care will be taken in its production as well as in its presentation, and in the case of wholesome meals the tendency will be to promote wholesome occupations, such as fishing (especially line-fishing) and shepherding. Thus we turn with interest to Mr Hammond's recent monograph on the *Growth and Development of Mutton* (Oliver & Boyd, 1932, 42s.), in which the science of the matter is discussed in detail. The histological and biochemical differences in different muscles are analysed, and the factors of tenderness and flavour which affect edibility. Most of the elusive features of the leg of mutton can be weighed and measured, and even beyond that the author ventured to go. He convened interested scientific guests at Cambridge, who tasted the various cooked muscles from the College kitchen and arranged them in order of merit. The two characteristics of tenderness and flavour vary independently. So there is good reason for obeying the familiar injunction : "*Revenons à nos moutons.*"

Cock-Crowing.—Some one on the farm might relieve his insomnia and make a name for himself by studying the night-crowing of cockerels. A note in *Nature* (27th August, 1932, p. 306) sums up some observations made in 1923 by D. Sinitsin, and

published in the following year in the *Records of the Bielorussian Institute of Agriculture.* Sinitsin made a fortnight's study of the night-crowing of a cock kept in his study at Minsk in Russia. It should surely be possible to cap that! There was no crowing before 11 p.m., and after 5 a.m. it was irregular. But in the intervening period it occurred with great regularity every hour, each crowing coming within ten minutes of the hour. The regularity was not affected by changes in atmospheric pressure, nor by music, light, and conversation in the study. The crowings at 2 and 4 a.m. were the most vigorous, and were accompanied by flapping of the wings. The cause of the regularity of the paroxysms remains obscure, though Sinitsin tries to connect it with "something in the atmosphere" and with the earth's rotation.

Bees and Light.—In the daily life of honey-bees differences of illumination probably count for a good deal, but precise and convincing observations are still too few. To what degree, for instance, is the bee able to distinguish different degrees of light and shade? Von Frisch finds that the differences in brightness must be enormous before the bee distinguishes between them, whereas another good authority, Von Hess, says that in this respect the honey-bee vies with man. They cannot both be right, and L. M. Bertolf has recently found that a compromise between the two conclusions is near the truth, though he is perhaps nearer Frisch than Hess.

Bertolf's experiments showed that bees begin to distinguish intensity of illumination when the brightness of one area is reduced to 70 per cent. of the other, whereas human beings can distinguish when the difference amounts to only 7 per cent. It is now necessary for some other experimenter to check Bertolf. For so does science advance in precision.

Mosquitoes and Light.—Great difficulty is ordinarily experienced in Britain in getting the common mosquito or gnat, *Culex pipiens*, to "bite" Naturally. In experiments on mosquito control it has often been a hindrance that only a very small proportion of the mosquitoes (*Culex pipiens*, *Anopheles maculipennis*, and *Aedes argenteus*) can be induced to feed on birds. But Messrs P. Tate and M. Vincent, working at Cambridge, have noticed an interesting fact. that females of *Culex pipiens* will gorge themselves with blood when placed in the dark (with, say, canaries) after prolonged exposure to light. but if kept continuously in the dark will only rarely gorge. Of those kept in the dark only about 3 per cent. gorged, while after exposure to light the percentage rose to 66-90.

Sulphur Bacteria.—Dr David Ellis is to be congratulated on his recently completed monograph on these interesting bacteria, which are widely distributed in Nature. They are well marked by containing globules of sulphur, and they are of much importance in the sulphur cycle. They restore to the soil in the form of sulphates much of the sulphur which occurs in combination, sometimes in living matter itself, in most organisms. When a plant or

animal is attacked by certain bacteria, it may be killed; then other bacteria begin its disintegration or decomposition, for there is no rotting without bacteria; and then there are others, like the Sulphur Bacteria, which complete the cycle by restoring elements to the soil, air, or water, from which they may be recaptured and brought again into the circle of life.

Parasites and Vigour.—In "Wild Nature," *i.e.* nature not greatly affected by human interference, disease is rare, but parasites are common. Yet these parasites are often of little or no importance to their hosts. A live-and-let-live compromise has been established, and many a wild animal has thousands of internal parasites without being appreciably affected.

An interesting light is thrown on this by some recent experiments on lambs by I. C. Ross and N. P. Graham, who find that good nutrition has a very salutary influence on parasitism. In improved pastures the tendency is for heavily infected sheep to throw off their parasites. Thus good nutrition in natural conditions will tend to check the multiplication of parasites. Vigour almost always counts in the struggle for existence.

Different Aspects.—We often make unnecessary intellectual trouble for ourselves by forgetting the partial or abstract nature of the various sciences. A science gives us not bedrock finished knowledge about things, but an account of what is discovered by using certain methods of measurement, analysis, and registration. A chemist has volumes to tell us about milk, but he is not as chemist much interested in the fact that the cow uses it to suckle the calf. That is the biologist's business. The geologist can tell us much that is interesting and valuable in regard to the surface-relief, the composition of the soil, the lie of the rocks and so on in our farm, but he is little interested in the crops, and not at all interested in the fact that the farm is beautiful. There is no doubt that there is a chemistry and physics of the living body, but this rarely tells us much about the animal's behaviour, and it never even asks about the creature's internal life of feelings, desires, images, and inferences.

The everyday chemical routine of the body, with its oxidations and reductions, its hydrations and dehydrations, its fermentations and adsorptions, its upbuilding and its downbreaking, is called the metabolism, and we may specify and speak of the carbohydrate metabolism or the protein metabolism. This kind of knowledge is indispensable, and it is a pity to label or libel the biochemical experts by calling them materialistic, if anything opprobrious is meant by that term. The methods and results are quite sound until it is pretended that they exhaust the aspects of the living organism, and exclude all need for or possibility of crediting the animal with something in the way of "mind" or subjective inner life.

We shall understand living creatures with increasing clearness as we know more and more about their metabolism; and interesting steps of progress are at present being taken in the way of

comparing the differences in metabolism in allied types, or in various parts of the body, or in the two sexes. Thus, to take a concrete example, Professor H. Munro Fox and Mr H. G. Simmonds have been telling us lately that there is a marked difference in the metabolic rate in related types living in different habitats. Thus that of the common freshwater crustacean *Gammarus pulex* is 1½ times that of the marine *G. locusta* and *G. marinus*; and the rate of the freshwater isopod *Asellus aquaticus* is 3 times that of the marine *Idotea neglecta*. "Comparing the oxygen consumption of the mayfly, *Bœtis rhodani*, an animal living in rapid streams, with that of its pond relative, *Chlœon dipterum*, we find that the former has a value 3 to 4 times the latter." Every biologist will look forward to a better understanding of animals—including farm-animals—in terms of their metabolic routine; what many of us protest against is the suggestion that this sort of inquiry excludes the legitimacy of a comparative psychology of the higher animals. It is indispensable, but it is partial; thus it does not help us much to understand the ways of the robin in our garden, who comes when we call or whistle, who sits on the chair beside us and passes the time of day, who goes to the kitchen for meals but has some other than cupboard pleasure in our company, who comes in by our open window before we are up in the morning, and so on and so forth. Is there a temperamental inquisitiveness, is there an awareness of the fact that man does not harm robins, is there some recognition of the safety of alert unpredictable movements? We need more than metabolism to elucidate these and a hundred other common sights which convince us that the life of a higher animal is far from being apsychic.

The Badger.—There has been much correspondence lately about the badger, which seems to be on the increase in various parts of Britain. Most of the letters in *The Times* and elsewhere were strongly on the badger's side, pleading for its careful conservation; and we are entirely with them, for several good reasons. The old-fashioned creature does almost no harm (even when at home close to a well-stocked duckpond!), it does no little good (*e.g.*, in keeping down wasps and checking the multiplication of rabbits); it is an old-fashioned creature, a relic of old times; and it has very interesting habits.

The badger is an animal of long pedigree, a historical treasure which cannot be replaced if we allow it to disappear. It used to be much commoner in Britain, as the many place-names like Brockhurst plainly show, "brock" being an old name for the badger. It is still far from rare in some areas, such as the New Forest, and Mr Tregarthen, who has given many years to its difficult study, reports the persistence of numerous "earths" in Cornwall and Devon.

The larger fauna of Britain was for the most part exterminated during the Ice Ages, when almost the whole country was thickly covered by great sheets of ice. After the melting of the ice there was a re-peopling from the Continent, with which Britain was

still continuous. The badger was one of the mammals that returned at that time. Since the insulation of our country was effected there has been a reduction of the larger and finer animals. Many, such as wolf, bear, beaver, and reindeer, have disappeared again; others, like the badger, linger as rarities. Among the important reasons for disappearance or for reduction in numbers we must reckon the cutting down of forests, the spread of agriculture, and the persecution of creatures which were inimical to man's interests, or libelled as such. The badger is at home in quiet wild places, the spread of farms and villages and sophistication has been greatly against it, but it is not yet too late to save it for our descendants. We are trustees of the fauna, and it will be a poor business if we have to say that we have lost the badger (as we have lost beaver, reindeer, pine-marten, and others) and gained two species of rats, which are both aliens, not to speak of cockroaches!

What we have said in regard to the tendency to the reduction of the native fauna of this or any similar country, where man's operations are dominant, raises the question of the factors in survival. How is it that the badger, for instance, has not disappeared long ago? Part of the answer is as follows: The badger is in great part nocturnal, it is a creature of the shadows, it is inconspicuous in colouring, it is a burrower, it is very hardy, it has a long bill of fare, it is a good parent.

What is the indictment of the badger, in reference to which man excuses careless killing? It is said to devour game-birds and poultry; and there is no doubt that it is occasionally carnivorous. On the other hand, it is mainly a herbivore, and it often does no harm to poultry and the like when the opportunities are great.

The strong odour of the male is blamed for confusing the scent of foxhounds. But this is a comparatively trivial matter when the risk of exterminating a very interesting animal is considerable. We do not mean that the badger is being hunted to death; what tells against the relic is its thoughtless destruction when detected on its peregrinations. We make no apology for badger-baiting, and we are not enthusiastic about fox-hunting, but it must in fairness be recognised that "sport" is rarely against the survival of a wild animal that is not markedly aggressive. In all probability we should have lost the fox long ago if it had not been for fox-hunting.

It is also said that the badger's extensive burrows are sometimes troublesome, as if they were common enough to write to *The Times* about. And some searchers for crumpled rose-leaves have had their slumbers disturbed by the badger's cacophonous serenading about Christmas time, when its impulses move towards love-making. Some people expect the whole world to conspire towards man's comfort.

On the other side of the account the badger, though mainly vegetarian, checks the increase of some troublesome insects like wasps, as well as of rabbits and other small mammals, of which

it is easy to have too many. The badger is a scarce solitary, never numerous enough to do much harm, and the interest of his structure and habits affords sufficient apology for the occasional damage he does.

A Plea for the Rook.—One of the many interesting papers at the British Association meeting in York was a careful inquiry by Mr D. Roebuck into the pros and cons of rooks from the farmer's point of view. It is easy to prove that rooks often do harm ; it is as easy to prove that they often do good, *e.g.*, in feeding their young for a time with insects, which include many that are injurious to crops. The scientific position is that before any drastic legislation is approved of, and recourse had to wholesale extermination (almost invariably bringing a heavy penalty), there should be a very extensive inquiry, over a wide area, and throughout the whole year. Only then can the pros and cons be wisely contrasted.

We are therefore glad to see that in the Midland counties of England Mr Roebuck took to do with 64,133 nests, 128,266 birds, and 1,421 rookeries. This is a wide basis, and the conclusion suggested is that the rook is not so black as he is painted, and that very harsh checking of numbers is not warranted unless it be locally and temporarily.

AGRICULTURE IN RUSSIA.

A. Muir, B.Sc.
Macaulay Institute for Soil Research.

Russia is a country of almost immeasurable agricultural possibilities. Its enormous area covers one-sixth of the earth's surface, and its climate ranges from Arctic Siberia in the north to the almost tropical Caucasus in the south. Between these extremes lie the vast forest regions and the great steppe zone, with its large expanse of fertile black soils, ideally suited for crop production. A further variety of climate and soils is found in the mountainous southern regions—the Crimea, the Caucasus, and Turkestan.

In a short article of this nature it is obviously impossible to attempt a complete survey of present-day agricultural practice in this vast land, but a brief summary of the salient features which came within the writer's observation during his fifteen months' sojourn in the country in 1930-31 may be of interest.

The revolution in Russia in 1917 brought about an abrupt transition in practically every phase of national activity : in agriculture the complete change over from little more than primitive systems to large-scale production by modern methods presented problems of special difficulty. In order to appreciate the magnitude and the complexity of this task, it is necessary to review very briefly the conditions of work and life on the land prior to the date of the revolution.

Under the primitive conditions obtaining almost up to the time of the revolution the two main classes in agriculture were the land-owning class and the peasant. Until 1861, the lot of the peasant in Russia was exactly comparable with that of the bondman under the feudal system in Britain. In that year the peasants gained a certain amount of freedom, but the conditions of work and life were changed but slightly. Only to a very small extent was the peasant master of his own destiny. The land-owners in some cases were genuinely interested in the welfare of their small tenants and peasants, but the large majority was interested only in the revenue which could be obtained from the land. The peasant had to do a certain amount of work for his master, and he generally managed to farm a small patch which would keep him and his family during the year. In some places the village owned or rented a large area, which was divided up among the villagers and run on the three- or five-field system. Here, the villagers had to pay the rent for the land either in money or in kind, the landlord taking no interest in agriculture.

Until towards the end of last century the landowners as a whole were content to produce only enough to satisfy the internal requirements of the country, and large-scale farming was of very small importance. About that time, however, it began to be realised that the vast tracts of black-earth soils were an enormous asset, since they could be worked for long periods under one crop without showing any signs of falling-off in crop yields. Scientific men, notably one Dokuchaiev, turned their attention to the study of this soil, and founded what is now known as Soil Science. It was still some time, however, before agriculturists began to make serious use of the results of scientific research, and in the end it fell to a landowner in the South to form the first experimental farm. This he did on the lines of the Rothamsted Station, as it was begun by Lawes. Others followed this lead, and at the beginning of the present century we find farming on a larger scale than had formerly been possible.

The improvement in methods of cultivation did not, however, do much to bring about the desired increase in yield owing to the extensive system of farming which still prevailed. The average yield per acre in Russia for the period 1901 to 1910 was 1¾ qrs. wheat, 2 qrs. barley, and 3 tons potatoes. During these ten years there was a slight decrease in the yield of wheat and a slight increase in that of barley, but on the whole these changes had little effect on the total output. The fluctuations in yield over a period are remarkable. Thus taking the lowest for spring wheat over the period 1883 to 1898 as 100, we find that the highest is 336. Live stock showed a large decrease during 1900 to 1912, reaching in the case of sheep and goats 27 per cent. Only in the case of horses was there an increase (5·7 per cent.).

An explanation of these decreases is found in the decrease in the amount of land per head of population. The agricultural population increased from about 50 millions in 1860 to 86 mil-

lions in 1900, resulting in a corresponding decrease in the amount of land per head of population. This decrease in some cases amounted to about 50 per cent., *i.e.* from 12 acres per capita to 7 acres. This " land hunger " caused great hardship among the peasants, lowering the amount of stock the small farms were able to carry, and in general lowering the standard of living of the peasants. To alleviate this suffering, the Asiatic Colonisation Bureau was formed. This bureau sent out expeditions, which made detailed surveys of various districts, and contributed greatly to the knowledge of the country. On the basis of this work peasants were transferred to Asiatic Russia, and found there a rich and fertile country.

The first revolution of 1905 had brought very few changes in its wake, and the peasants were very ready to follow the lead of the town workers when the great revolution of 1917 took place. Having thrown off his yoke of servility, the peasant simply carried on his farming in the old way. None of them was rich enough to purchase the new machinery, and that which belonged to the rich landowners was often destroyed, and in any case there was not enough to go round. The problem which confronted the new government was how to apply the Marxian theory of economics to such a great problem. Lenin summed up the position in the following words : " To live the old way, to live as people lived before the revolution. is impossible, and such an expenditure of human strength and means as is connected with peasant farming can no longer continue. The productivity of human labour would be doubled and trebled, the savings in human labour for agriculture and the economic system of humanity would be doubled and trebled if the transition from these scattered farms of small size to socialised farming could be made."

The socialisation of agriculture has proceeded along two lines—the formation of state farms (sovhozes), and of collective farms (kolhozes). Farms of both types were formed immediately after the revolution, but these did not become factors of any importance until recently. From 1921-27 there was a large decrease in the number of the most highly collectivised farms, due simply to over-eagerness on the part of those sent to organise them. Those chosen for the work were no doubt good communists but bad psychologists, as was shown by their failure to find the proper approach to the humble but suspicious peasant. Many of the brigadiers, as they were called, had absolutely no notion of practical farming.

The " sovhoz " is run by some trust which is directly responsible to the central government. Each farm has a manager, mechanics, labourers, etc., who are simply paid servants of the State, and are in no way affected by the success or failure of the crops. These farms, which in some cases have reached a colossal size, *e.g.*, the Gigant in the North Caucasus, which has an area of 450,000 acres, are the basis of present-day agriculture in Russia, and towards this form all others tend.

In the collectivised sector there exist three types of farms. The first and most primitive is simply an association for the joint tillage of the soil. The products of the land are divided up at the end of the year according to the amount of land owned by each family. This is only the first step towards further collectivisation, of which the "artel" represents the second. Here we have almost complete collectivisation, each family being left only one cow and their hens for personal use. In the final stage of collectivisation—the commune—everything is collectivised, except, of course, personal belongings. This state of affairs is found but rarely, the peasants being encouraged to increase the productivity of the land rather than bother about communal houses.

The collective farms are run by a committee elected by the villagers, and sometimes, if the village is small, all the villagers may take part in the work. A president and secretary are chosen by the committee, and they together act as the executive body. An agronomist is generally to be found in each village, but if the district is sparsely populated, one agronomist has to suffice for the whole district. Attached to many of the farms are tractor stations, which are assuming greater importance as the production of tractors increases. The Stalingrad factory was recently producing about 110 tractors per day, and the Leningrad factory about 90. The chief difficulty found in the use of tractors is the lack of spare parts, and it is not uncommon to find most of the tractors in one station laid up owing to some minor trouble. The peasants have on the whole taken fairly well to the mechanisation of agriculture, and are ready and willing to learn the handling of the various modern machines which are now at their disposal.

The working day is generally one of ten hours, but weather conditions and other factors outside the peasants' control may necessitate much longer hours sometimes. Lateness in the delivery of seed, an increase in the sowing area, and mechanical breakdowns in machinery are common causes of delay, giving rise to the necessity for extra work. During the sowing and harvesting season it is not uncommon to find a night-shift being worked with the aid of headlights. The area sowed must be increased every year, and every district is required to furnish a detailed programme for each financial year. When the total production falls short of the requirements of the plan, the area is increased very often without any regard to the capabilities of the peasants and the conditions under which they work. This is generally responsible for many of the poor crops very often produced by the collective farms.

When the harvest is brought in, the government takes a pre-arranged portion at a fixed price. The remainder is divided among the members of the farm. In some cases the whole of the produce is sold and the money received is divided up according to the amount of work done. A strict record of the work per-

formed by each member of the farm is kept, and it is according to this record that the final division is made. Quality counts just as much as quantity.

The contract system has been applied in certain cases in order to ensure that there would be sufficient supplies available to the government for State marketing. This system also ensures the peasant a higher standard of living than he would otherwise obtain. More up-to-date machinery and implements are granted to those farms contracting, and the transition to collective farming is thus rendered easier.

Some idea of the proportion of crops contracted for, in relation to total area sown, is given in the following table :—

Crops.	1928 Per cent.	1929. Per cent.	1930. Per cent.
Summer corn . .	4·3	25·0	30·0
Winter corn . . .	14·7	32·7	..
Cotton	100·0	100·0	100·0
Flax fibre . . .	20·5	36·8	37·9
Sugar beet . . .	100·0	100·0	100·0
Tobacco . . .	66·3	74·9	100·0

This system is being applied more generally each year, and production by this method will eventually reach 100 per cent. for every crop. Recently new regulations have been introduced to allow the peasants to retain a larger proportion of their products than formerly, but these will not affect the contracting system.

The status of women on these farms is the same as that of the men. They enjoy just as much freedom, and their work counts equally. In most villages crêches have been established, where the children are well looked after by a trained teacher or nurse, while their mothers are at work in the fields. When the children reach the age of seven they must attend school. At that age most of them have learned to read, write, and count, and they continue at school until they are fifteen. It is when they leave school that the change in the system of government has effected most. Under the old system it was very difficult for a peasant to proceed to the university, but that is now changed, and while the student is attending his classes, he receives a grant which enables him to live without depending on his parents for everything.

With regard to food supplies, we find that in some cases the peasant is better off and in others worse. It all depends on his standing before the revolution. If he was well-to-do before the revolution, he feels the pinch now, but if he was of the poorer class, then he is really much better off. The distribution of material requirements is carried out entirely through the co-operative societies, and it must be said that this distribution is generally the cause of many of the food shortages. There have been numerous cases where food has been found lying in stores while people were going without. A "purging" of the various departments and stores takes place at regular intervals, and those

responsible for any grave deficiency in supply are generally brought to book. Two examples of the vagaries of distribution may be given. One village in the south had sent to it seven men's suits. The population of the village would be about 2000, at least 500 of these being men. The storekeeper was at his wits' end as to what to do with the suits—so they lay in the shop. In the end they would probably be given to some of the members of the "Shock brigades," to which reference is made below.

Another example concerns the distribution of sugar and cereals. For a whole month a little town had been going without either of these necessities, while a small village a few miles away had plenty. In fact the party to which the writer was attached had to get supplies from this village. The nearest large centre was about 40 miles away, and although motor lorries were travelling between the two points every day, they did not seem to think of sending supplies by these means. The lorries arrived empty and left full of fruit and grapes.

These examples could be continued, but enough has been said to show the state of affairs.

In most farms, as in factories, the peasants form themselves into "Shock brigades," and these vie with each other in producing the best results from their labours. These "Shock brigades" generally set themselves a definite piece of work, and then strive to get it done as quickly and efficiently as possible. Their rewards are more spiritual than material. If a brigade is highly successful in its work, it may gain a Red Banner, which is a much-coveted award. Individual members may be awarded the Order of Lenin, but this is given only after long service with the party. Sometimes members of the "Shock brigades" receive gifts in kind, and the writer was present at a distribution of such awards, when these included an overcoat, a pair of boots, a primus stove, a samovar, and so on.

An interesting series of figures was given by Jakovlev in 1931 for the distribution of collective farms in relation to three of the main economic regions of the country.

Percentage of Collectivised Farmers to Total Number of Peasants.

Region.	1928 Per cent.	1929. Per cent.	1930. Per cent.
North Caucasus, Lower and Middle Volga, and the Ukrainean Steppes	3·5	7·4	48·8
The rest of the grain-producing regions	1·6	4·0	25·5
The consuming regions	0·5	1·5	8·5

The figures for 1931 show still further increases. The explanation of the large difference is easy to find. The peasants in the vicinity of the large towns find it much more profitable to remain outside the collective sector and to sell their produce in the open markets in these towns. In the other regions they have not the same facilities, and therefore it is much easier to get them to

collectivise. Of course, the first and second regions being the chief grain regions, the government paid special attention to the collectivisation of these districts. There is difficulty in forming large farms in the north owing to the occurrence of great tracts of forest and peat bogs. Very little attempt is made to cultivate the peat, but it is largely used as fuel, since in the north, especially in the Leningrad region, there are no coal deposits of any importance. To compensate for the lack of coal, however, the north has very extensive mineral phosphate deposits, which are used to supply the large phosphate deficiency found in all the northern soils. The main crops in the north are flax, oats, and rye. Attempts are now being made to concentrate around the large towns market gardens, which up to the present have been scattered over a fairly large area.

The transition to modern farming methods has thus been going on with varying degrees of success since 1917. During the period of civil war the area under crop decreased by about 20 per cent., and did not reach the pre-war level again until 1925.

During the last few years, however, the grain output of the country has increased enormously, as can be seen from the following figures. Two sets are given, one for the collective farms and one for State farms :—

Year.	State Farms.	Collective Farms.
1927 . .	..	2·0 mill. cwt.
1928 . .	6·4 mill. cwt.	3·6 ,, ,,
1929 . .	7·9 ,, ,,	12·7 ,, ,,
1930 . .	18·0 ,, ,,	82·0 ,, ,,

Figures for 1931 are not available, but the increase in production certainly would be continued, as a much larger area was under crop. The expected yield would not, however, be obtained, owing to the fact that weather conditions were most unfavourable to cereals during the whole growing season. Spring was fairly dry, and the crops as a whole suffered a check, and in autumn rain prevented the harvest taking place at the usual time. Oats were seen in the Crimea in August still green, and only about a foot high. Even where the crops got a good start, the late rains generally spoiled the yield. Tobacco was one of the few crops which did not suffer. The south coast of the Crimea, which is one of the largest tobacco centres, was favoured with sufficient rain in spring, and it was possible to sow the crop in places which had been untouched in previous years. The yield was very high all along the coast.

To conclude this brief account of agricultural conditions in Russia, a few notes on agricultural science may be added. Agricultural science in Russia may be said to date from the eighteenth century, but in most branches the contributions of Russian scientists were very meagre until the nineteenth century. During that century the possibilities of expansion in the agricultural markets gave science the necessary impetus, and towards the

end of the century we find the Russian scientific men coming into their own. The study of the soil as a natural body was the chief contribution from Russia. In 1883 Dokuchaiev issued his monumental work on the Russian Black Earth, and the principles which he laid down in that work have become the foundation-stones of the modern study of the soil. The practical aspects of the problem were not ignored, but the Russians felt that a thorough study of the actual process of soil formation would give in the end a more complete picture of the conditons obtaining in the soil, and hence a surer basis for rearing the structure of applied soil science or agronomy, as it is now known.

Dokuchaiev had many illustrious pupils, and these in turn carried on the task of making a complete study of the soils of their vast country. Small-scale maps of both the European and Asiatic parts of Russia have been issued, and an attempt is now being made to cover every important part of the country on the scale of 1 inch to the mile. These soil surveys are made the basis of any agricultural expansion and for the introduction of new crops.

In other branches of agricultural science the achievements of the Russian scientists have not been so marked. Since the revolution the network of agricultural experiment stations has been brought into better co-ordination, and all problems are investigated on a co-operative basis. Thus, instead of each station working away independently on its own region, the problems cropping up in that region are attacked by a number of institutes, and thus the final results are far more valuable than if each had pursued a line of work regardless of the others. This co-operation is seen in the so-called "complex" expeditions which are sent out by the Academy of Sciences. We may take as an example the expedition sent to investigate the salt lakes of Siberia. It was well known that the salt content of the lakes was high, and that it would prove profitable to work them. However, difficulty at once arose from the fact that in the neighbourhood the soils were so impregnated with salt that cultivation was impossible. Thus, to investigate the region properly, there were needed: geologists, to study the salt deposits and other rocks in the vicinity; botanists, to study the present flora; soil scientists, to study the soil and advise on the proper methods for bringing it into a state fit for cultivation; lastly, chemists, to study the methods for extracting the salt. This expedition will return again this year for more detailed study of the region.

Time alone will show how this great experiment is going to work out. Many of the difficulties often appear insuperable, but by whole-hearted co-operation they may be overcome. The general backwardness of the agricultural population has been one of the controlling factors, but by raising the cultural level of the people a higher efficiency should be obtained. The people on the whole are in sympathy with the new system, and that means a great deal. A rigorous application of Marxian principles to

agriculture has proved impossible, but suitable modifications would appear to have been of great value in ordering the life and work of that vast country.

SILAGE AS A CHEAP MEANS OF PRESERVING HOME-GROWN FODDER.

A. W. Oldershaw, B.Sc., N.D.A.

During the ten years from 1913 to 1923, there was a very rapid extension of the silage system in Great Britain and Ireland. Tower silos were erected in most parts of the country, whilst other types of silos were also used extensively.

Since 1923, owing no doubt to the acute economic depression in agriculture, comparatively few new tower silos have been built, as these structures are costly to erect. On the other hand, the practice of making silage in trenches, pits, and stacks has probably extended, as little or no capital outlay is involved in these cases.

Silage as an Alternative to Hay.—Silage may be considered as an alternative to hay or to roots. If the weather were always ideal at hay-making, probably few would make silage instead of hay. In Great Britain and Ireland, however, it frequently happens that very great losses occur in hay-making owing to bad weather. In seasons such as 1930 and 1931, it seems very likely that one-third of the total nutritive value of the hay was lost owing to weather conditions. In a wet season very large sums are also lost in expenditure on labour in the hay fields, because rain may fall immediately after the operation is performed, and the work has to be repeated when the weather turns fine. It is impossible to estimate this loss, but all who are familiar with the great waste of time which takes place in a wet hay harvest realise its seriousness. The great loss in the nutritive value of the hay in a wet season and the immense superiority of good, as compared with weathered, hay is too well known to need emphasis.

The most serious objection to making silage is the fact that roughly three times the weight of material has to be carted as compared with hay. There is also a very variable amount of loss of nutritive value in the silo. This loss differs greatly with the method of ensilage adopted and the skill used in the work, but even when the most inexpensive silos are used it need not approach the loss which takes place in hay-making in a showery season.

The individual farmer must decide whether the losses he is likely to incur in labour costs and in the nutritive value of the material if made into hay are in an average season greater or less than the labour employed in making silage and the losses likely to take place in the process. It is evident that the wetter and

later the district in which any individual farms, the greater are the claims of silage as compared with hay.

As an Alternative to Roots.—As a food stuff silage has very little resemblance to roots, as far as its composition is concerned. The latter are essentially carbohydrate foods of a highly digestible character, whereas silage is more like wet hay or even average grass. It is much better "balanced" as a general food than are roots. Only as a succulent food available in winter can silage be held to resemble roots. As a winter succulent it is undoubtedly of great value.

Where silage is made from arable forage crops grown for the purpose, such as oats and tares, oats, beans, and tares, oats and peas, and so on, these crops often take the place of roots in the rotation.

An average crop of a silage mixture such as the above, say 12 tons per acre, may contain 2½ tons of dry matter, which is similar to the amount contained in a fair crop—25 tons per acre—of roots. In the case of the silage crop a July and August fallow may be made after the removal of the crop, and in early districts it may be possible to secure a catch crop of white turnips. This is frequently done in Suffolk. On heavy land, where it is difficult to secure a good tilth for roots, there are many points in favour of the silage crop, which is certainly much less expensive to grow. The silage crop is sometimes rather difficult to cut, but it is much less watery than roots, so that the actual weight of roots to be carted may be two or three times greater than that of the silage crop. This involves much less labour in the case of the silage. The cartage of the roots also takes place in autumn and early winter when the land is wet and apt to be seriously poached by carting off a big weight of roots per acre. The manual labour of the stockmen employed in feeding silage, whether long or chaffed, is much less than that in feeding roots. Silage, once it is efficiently made and if air and water cannot gain access to it, is not so liable to rotting and loss in winter from frost or other causes as are roots. Moreover, it may be left over for another season, if air and water can be kept from it.

In certain parts of England cheap green fodder for silage can be grown by utilising such plants as lucerne, sainfoin, and maize. In Scotland it seems probable that much could be done, by the aid of farmyard manure and of the cheap nitrogenous and other fertilisers at present available, with such plants as Italian rye grass, cocksfoot, and timothy, and also with meadow grass. These, if heavily manured, grow large weights of green stuff per acre at very little cost per ton, and are easier to cut than mixtures containing vetches.

As an Aid to Intensive Stock-farming on Arable Land.—There is good reason to believe that a larger head of live stock can be kept on a farm of which a good proportion is arable than where most of the land is under grass. This is especially the case where the grass land is not intensively manured. Permanent grass is

not infrequently low in productivity and often does not contain a large enough proportion of those grasses which grow the greatest weight per acre. Even if well manured it sometimes gives a somewhat disappointing response.

Temporary grass mixtures, including a good proportion of the larger grasses and wild white clover, may, on the other hand, be very productive, especially if heavily manured. Mixtures of forage plants such as oats, tares, peas, and beans also produce a very large weight of green stuff per acre. Very heavy crops of grass or forage mixtures are difficult to make into hay, but can easily be made into silage. Such crops fit very well into a system of arable stock-farming. The land tends to become enriched, and good crops of cereals—the straw for forage and litter and the grain to reduce expenditure on purchased foods—can be grown after them. Thus an abundance of winter food is produced for the cattle.

As a Food Stuff.—The most satisfactory way of regarding silage made from grass, oats, tares, and similar crops seems to be as a succulent alternative to hay. For practical purposes 3 lb. of such silage is about equivalent to 1 lb. of hay. Maize silage is much more watery and more resembles roots. Sugar beet top silage and potato silage are also quite distinct in type from ordinary silage made from green crops. Much experimental work on the feeding of silage has been done during the last fifteen years or so, and it has been fed under ordinary farming conditions on a very large number of farms. This experimental and practical experience has established beyond all doubt that it is a thoroughly satisfactory food to give to practically all classes of cattle. When properly fed, after milking, it does not taint milk. Milk produced by silage-fed cows has been consumed in the writer's household for the past fifteen years, and no taint has ever been noticed.

It is also suitable for fattening stock and for stores, for sheep, and, in limited quantities, up to 14 lb. daily, for horses. It is not suitable for pigs.

It is worthy of note that the crops grown for silage usually contain a good proportion of leguminous herbage, fairly rich in protein. This serves to balance the protein deficiency usually characteristic of other home-grown foods.

Types of Silos.—In a previous issue of this *Journal*[1] the writer gave an account of various types of silos, grouping them under the headings: 1. Cylindrical concrete. 2. Concrete block. 3. Brick. 4. Metal. 5. Wooden stave. 6. Patent wooden. 7. Those made from disused buildings. 8. True pit. 9. Disused gravel pits. 10. Earth-covered heaps. 11. Stack. 12. Trench silos. Of these, the first six are tower silos, *i.e.* tower-like buildings erected for the special purpose of preserving green fodder.

It may not be out of place to review briefly the experience gained since the above article was written.

Tower Silos.—The erection of a tower silo involves the outlay

[1] Vol. vii., No. 2.

of a considerable amount of capital. A cutter and blower has to be provided, as well as an engine or tractor to furnish the power. Occasionally it is possible to place a tower silo in a disused gravel pit or quarry where the green material need not be elevated, in which case a blower is not necessary. The actual amount of capital required for the erection of a silo varies greatly. In the past very substantial and inexpensive concrete silos have been erected in Suffolk and elsewhere by the farmers' own men with the assistance of a local builder.

Tower silos require a staff of men to fill them, the number being more or less similar to that required for an ordinary day's thrashing.

If well made, so that no air can gain access through the walls, tower silos make excellent silage, with very little waste. If, when full, a layer of long green grass is placed at the top, and the whole then covered up with sand, the waste is reduced to a point which may be regarded as negligible.

The writer has taken an opportunity of observing the durability of tower silos erected during the past fifteen years.

The numerous cylindrical monolithic concrete silos erected from 1915 to 1925 appear to show little or no signs of wear in the main structure. Where the roof and chute is of wood, rubber composition, or galvanised iron, this part of the structure has in many cases perished to some extent. The walls, *i.e.* the main part of the silo, appear likely to last a very long time. It would seem desirable to make the roof and chute of a concrete silo of the most permanent material possible, otherwise repairs will be necessary after a lapse of twenty years or so.

A roof and chute of concrete would probably prove permanent. The statement occasionally made some years ago that the acid of the silage would adversely affect the concrete appears to be mistaken, if the inside of the silo is properly smoothed. Any possible risk of this, however, can be obviated by a coating of tar and paraffin mixed, which can conveniently be applied during winter as the silo is being emptied. In one case (a metal silo with a concrete base), the liquid oozed out of the silo and dropped upon the concrete base, causing it to perish to a slight extent.

Concrete Block Silos.—In the previous article referred to particulars are given of a concrete block silo erected by Mr A. J. Jeffers of Drumleck, Castlebellingham, in the summer of 1922. Since then Mr Jeffers has erected another similar silo, also 40 feet high, and eight silos of the same kind have been erected in the neighbourhood. They have not so far shown any signs of decay worthy of note in any part. No tar was used on the inside of the silos. These silos have been working at full capacity since they were built. Mr Jeffers considers they have reduced expenditure on feeding stuffs, especially for concentrated foods and roots.

In his district grass cut in or before the flowering stage is being substituted to some extent for special silage crops such as beans, vetches, oats. This grass makes lovely feed. It is chopped up

and elevated into the silo by a " blower " driven by a tractor or traction engine.

By giving a heavy dressing of farmyard manure, it is found possible to get two good cuttings of grass in the year, one in June and the other in September. With the aid of grass dressed with phosphates and sulphate of ammonia, and of silage crops, the stock-carrying capacity of Mr Jeffers' farm has been doubled.

Brick Silos.—Some of these have been a success, but one cracked badly. Where wood and rubberoid have been used for roofing, repairs have been necessary.

Metal Silos.—One of these, erected about seven years ago, has never been painted. It is now in very fair condition on the outside, but is getting rusty inside, especially in the lower part. It has been unused for three years.

A second metal silo under observation was erected about ten years ago. During this period it has been filled every year but one. It has been painted on the inside every year it has been in use. A wire brush is used to brush down particles of adhering silage and so reduce corrosion. The roof on the inside is going rusty, and before painting on the outside corrosion began in one spot, but on the whole the silo is in good condition, and looks like lasting fifty years in all.

Wooden Stave Silos.—Quite a number of these silos were erected in East Suffolk in the period from 1913 to 1923.

Of those erected earliest some appear to be not very much the worse for wear on the walls, and look like lasting another 20 years, *i.e.* roughly 40 years in all. The roof is usually slightly decayed, and occasionally a stave has slipped in the walls. Those which have received the closest attention have usually been creosoted on the outside, and care has been taken lest they blow down when empty and dry, as has happened in at least one case. Occasionally the silo has assumed a leaning position, and it has been necessary to put additional bands round it, and to attach wire ropes which can be screwed up, in order to prevent it from falling over. Where for various reasons a wooden silo erected 15 years ago has been neglected or unused, it shows very obvious signs of decay. On the whole, the life of a wooden stave silo which is very carefully watched, creosoted, and attended to in every way, seems likely to be from 40 to 50 years in our climate.

A Patent Wooden Silo erected on a farm some five or six years ago was in good condition when examined in 1931. It has now been taken down and the wood used for another purpose.

Unused Silos.—Quite a proportion—probably in the neighbourhood of one-third—of the tower silos erected within the past 20 years are now unused. This result is principally due to a change in the occupier of the farm owing to death, change of tenancy, sale of the farm, or other reasons. Occasionally an occupier has changed his system of farming, and no longer requires his silo. Where a silo was erected by an owner-occupier who is still in occupation, the silo is nearly always still in use. Experience has

shown that a fresh occupier coming into a farm equipped with an efficient tower or other silo does not always use it. He has, perhaps, not been accustomed to a silo, and does not appreciate its value. Also he may adopt a system of farming which does not involve the keeping of many cattle. It is quite evident that silos are best erected by owner-occupiers. A landlord erecting one for his tenant might very likely find that the next tenant did not require such a structure and would not use it.

This is the very strongest possible argument in favour of the use of simple methods of ensilage which do not involve heavy capital expenditure.

Disused Buildings.—As already noted in this *Journal*, quite a number of disused buildings have been utilised as improvised silos. These have proved satisfactory and have saved the expense of erecting a more costly structure.

Several other methods of making silage, involving practically no appreciable capital expenditure, are worthy of the closest attention. Of these, the mos tsatisfactory seem to be "Clamps," or earth covered heaps, stacks, and "Trenches," or shallow pits.

Clamps.—I have used this expression to describe cases where a heap of green material is made on the surface of the ground, without any excavation, the heap being subsequently earthed up. The heap may be made somewhat on the lines of a manure heap. It is important, however, that it should not cover too large an area, that it should be well consolidated and carted over, carried up to a height of several feet, and roofed over in such a way that neither air nor water can gain access. No straw should be put upon the ground; the green material should be simply dumped down and levelled. The most convenient shape for a heap of this kind is fairly long, and about 12 to 15 ft. wide.

If made with care, such a heap will result in excellent silage, and there need not be a very large amount of waste. From investigations conducted by the writer this method seems to be one of the best ways of making silage from sugar beet tops.[1]

Wallace[2] has found that surplus potatoes mixed with green grass can be made into silage by a modification of this and of the stack silage method.

Sugar beet tops differ considerably in character from materials usually made into silage, such as meadow grass, tares, and so on. They contain much more moisture, whilst they are usually made into silage in late autumn or winter when there is very little drying. Dry air does not therefore gain access on the sides very much, even if they are not covered up, and there is comparatively little loss from this cause. The material is usually used up before summer. On the other hand tares, peas, or other open material, put into a clamp in summer, need protection on the sides of the clamp as far as possible or serious loss will occur through drying and consequent mould. Meadow grass is less open in texture, and is less likely to suffer damage from this cause.

[1] *Journal of the Ministry of Agriculture*, October 1929. [2] *Ibid.*, January 1930.

Stacks.—In this case the green material is made into a stack on the bare earth. The base is best made circular, as this shape gives a smaller outside surface without corners, and consequently less waste. The great disadvantage of stack silage is the fact that air gets access to the sides, the material dries for a varying distance inwards, and mould sets in. Any means taken to protect the outsides from drying reduce the proportion of waste. For this reason it is best to put the stack in a sheltered position, away from drying winds. The character of the material used and the time of the year at which the stack is erected also makes a considerable difference. Meadow grass is more suitable than tares and oats for stack silage. Other things being equal, a stack of aftermath put up in October would suffer less loss than a stack of grass erected in July, as there is comparatively little drying after October. The writer has found that it is possible to make excellent stack silage from even such open material as green maize, in October.

In making the stack the green material should be carted as soon as cut and well trampled round the outsides, and the stack should be made a fair height.

If possible the loads should be unloaded at different places all round the stack, as this will conduce to uniform settling. If the stack is erected gradually, it will settle better, and be less likely to slip or fall over. The walls of the stack should be almost vertical or, if possible, very slightly drawn in, to provide a steep slope for the rain-water to run off after settling.

The eaves should not project as in a corn or hay-stack, as this will lead to more air gaining access.

The amount of settling which takes place is really remarkable. In some tests at Cambridge conducted by Mr F. Hanley, M.A., the following figures were obtained,[1]

June	9th.	Stack begun and reached 8 ft. 6 in.
,,	10th.	Stack settled to 6 ft. and then stacked to 14 ft.
,,	12th.	Stack settled to 8 ft. and then stacked to 14 ft.
,,	13th.	Stack settled to 10 ft. and then stacked to 16 ft.
,,	14th.	Stack settled to 14 ft. 6 in. and then stacked to 17 ft. 6 in.
,,	18th.	Stack settled to 9 ft. and then stacked to 16 ft.
,,	20th.	Stack settled to 13 ft.
July	14th.	Stack settled to 9 ft. 6 in.
Dec.	31st.	Stack settled to 7 ft. 6 in.

In erecting a silage stack a pony is occasionally used for trampling. If an elevator is available, the very heavy labour of putting up the green stuff will be reduced. A very steep roof should be made, and this may be covered with sand or earth which may be elevated by means of a hoist. The roof should be carefully made, to ensure that the slope is regular and that no hollows are left where rain-water will pipe into the stack.

Some prefer to top up the stack with rough hedgeside stuff

[1] Ensilage—*Ministry of Agriculture, Miscellaneous Publications*, No. 53.

and inferior grass, and to put on no further covering. Although the waste in making the stack silage may be considerable, yet it may be reduced by taking every possible care to keep air out of the sides and rain-water out of the roof. Quite a number of farmers made excellent silage in this way from meadow grass during the two wet hay harvests (1930-31), under the observations of the writer, and excellent material has resulted. One farmer has found that instead of cutting the stack with a hay knife, it is better to use the material from the top downward without cutting. This, he claims, saves mould on the cutting.

Trench Silage.—In the light of experience gained since 1924, I consider that for ordinary green material this method is superior to both clamps and stacks for making silage without heavy capital expenditure.

The exceptions to this rule are that for sugar beet tops and potatoes I prefer a modified clamp-like structure. Sugar beet tops required very complete drainage on the sides, and are better entirely above ground.

For ordinary green materials I consider the trench superior to the clamp, because as it goes 4 or 5 ft. below the ground, down and in erection the green material goes up several feet above ground, the total mass in a bulk is greater, and hence the proportion of outsides and top is less.

Its superiority to the stack is due to the fact that the sides are not exposed to the air, but are either below ground or covered with earth, and if it is well made there is very little waste on the sides either from mould or wet. In addition the labour of erection is very much less than in the case of a stack. The bulk of the material is simply tipped out of a cart and then carted over.

When it has been decided to make silage in this way, the first point to be settled is the site of the trench. The trench is best prepared in the winter, when the soil is wet and labour is usually available. A careful record of the cost of digging a suitable trench was kept in two cases. In one case a trench 36 ft. long, 13 ft. wide at the top and 11 ft. wide at the bottom, 5 ft. deep at lower end and 4 ft. at shallow end, cost £5, 2s. 8d., the wages of the men being about 6d. an hour at the time. The soil was hard and much picking had to be done. A drain 10 yds. long was provided at the lower end, to the nearest ditch.

In another case a trench 36 ft. long, 12 ft. wide, and 4 ft. deep at one end and 5 ft. at the other was dug in 136½ hours. This at 6d. an hour (the wages at the time) cost £3, 8s. 3d. Including a small sum for rent, rates, insurance, and drain pipes to the nearest ditch, the total cost was about £4.

The following points have been noted as of possible use to those intending to make trench silos.

Size of Trench.—A convenient width is 12 to 15 ft.; this just enables a cart to draw on to the heap when nearly full. It is a mistake to make it too narrow or too wide. The length and depth will depend upon the quantity of material to be ensiled.

It is an advantage to have the pit a good depth, as that results in a larger quantity of silage being in one mass, and reduces the proportion of outsides. On heavy land, where drainage is necessary, the trench cannot be quite as deep as the ditch or outfall into which the drain must run.

Trench silos actually in use vary in depth from 2 ft. 6 in. to 9 ft. The sides and ends of the trench should be nearly, but not quite perpendicular.

The following actual cases will give some guidance as to the size of pit necessary.

Length.	Depth.	Width.	Number of acres of crop ensiled.
25 yds.	4 ft.	15 ft.	50 acres lucerne.
15 yds. from end to end, but end slopes upwards.	3½ ,,	10 ,,	6 acres heavy crop of rough grass.
16 yds.	9 ,,	14 ,,	32 acres tares.
15 ,,	4 ,,	15 ,,	25 acres tares.
7 ,,	4½ ,,	15 ,,	7 acres very thin crop of oats and tares.
14 ,,	4½ ,,	13 ,,	7 acres heavy crop of tares.
5 ,,	3½ ,,	12 ,,	3 acres tares and oats.
13 ,,	5 ,,	10 ,,	8½ acres fair crop of rye and tares.
10 ,,	5 ,,	12 ,,	8 acres oats and tares.

The contents of a given silo will naturally depend to a great extent upon the height which it is carried above the ground. As a rough rule it may be estimated that with a pit 14 ft. wide and 4 ft. deep about 1½ yds. in length will be wanted for every acre of an average crop of oats and tares to be ensiled. The first trench referred to above was made not less than forty-five years ago and has been in regular use since. In 1931, second crop of lucerne and second crop of clover and rye-grass were made into silage in trenches on this farm. They would have been worthless owing to wet weather if made into hay.

Drainage of Pit.—On light soil there is no difficulty about drainage as all water soaks into the soil.

On heavy soil there is usually danger of water accumulating in the pit in winter, when the silo is partly empty. This water will cause any silage which it reaches to rot. For this reason on heavy land the trench must be made near a ditch or outlet for the water. In order to facilitate this, one end of the silo should be made a little lower than the other, and from the lower end a drain should be arranged to carry the water away. In some cases the pit is made with a sloping end so that the carts can back in when removing the silage, but this results in rather more waste.

Filling the Silo.—The first few loads of green stuff should be tipped into the silo at each end. After some bulk of green stuff

has accumulated it will be possible to take a horse down and commence trampling. This trampling should be carefully performed, especially round the outsides, throughout the whole operation, especially during the later stages. As soon as possible the carts, both full and empty, should be drawn on to the green material. The process continues until not only is the pit filled, but the mass of green material is carried upwards (with walls very slightly drawn in) as high as possible above the level of the surrounding ground before roofing is begun. A slope of green stuff has to be made at each end of the pit to allow the carts to ascend and descend.

The object of taking the heap as high as possible is to allow the green stuff to sink into the pit. In some cases the heap is carried to a total height of 12 ft. above the ground before sinking.

The heap must be well rounded up on the top to finish off. This must be done by hand. The sloping ends should also be cut off and placed on the top. The last few loads placed on the top should be rakings or other inferior material, or hedgeside stuff.

Covering.—As soon as the heap is well topped up, it should be covered on the top with earth. If the heap has been carried to a considerable height it may be necessary to use a platform in order to get the soil on to the top. The sides will not require covering at first as they will sink into the pit.

About 6 to 8 in. thickness of soil should be placed on the roof. After the silo has been covered with earth on the top, it is desirable to look over it a few days later and fill up any cracks, etc., caused by the material sinking. As soon as sinking has finished, the whole of the material remaining above ground should be covered with earth.

It is very desirable that the final shape of the roof should show a good slope.

In some cases loss has been caused by the green material sinking and forming a sort of elbow just at the eaves of the roof.

If this appears likely to happen, any elbow should be pared off, and if necessary a rough thatch arranged over the roof to keep rain-water out. Occasionally the roof has been covered with thatch or galvanised iron, some time after being made and when well moist, and this has been successful in preventing rain-water from gaining access to the silage.

Stage at which Crop should be ensiled.—There is evidence that the best stage for oats and tares is when the pods begin to form, and before there is any appreciable amount of corn. If left until later, there is usually considerable waste owing to rotting of the tares against the ground.

When the crop is placed in a silo at a fairly early and very green stage it is probably best to allow it to remain in the field for a day after cutting in order to allow it to become a little wilted. On the other hand, if the crop is rather dry when cut it is best put into the silo immediately.

If the material is too dry a great deal of loss may occur owing

to mould. Second crop of clover, in September, is very apt to become partly ripe and dead ; when this happens loss from mould may easily occur unless the crop is put in the silo in a very moist state immediately it is cut, and even then it may occur. Second crop of clover should be cut early for silage before it is at all ripe. If the crop is too wet, the silage will be very sour and have a rather disagreeable smell. In the case of meadow or upland grass, clover, lucerne, and similar crops, it is as a rule best to ensile the material immediately it is cut.

Causes of Failure and Excessive Waste in making Trench Silage:

1. The crop is placed in the silo either too wet or too dry.
2. Insufficient consolidation, especially around the outsides.
3. An imperfect roof with insufficient slope, which allows rain-water to enter the silage and rot it.
4. On heavy soil an accumulation of water in the partly emptied trench, owing to drainage not being provided.

If these causes of failure are avoided there is no reason why trench silage should not be made with very little more waste than usually occurs in a cylindrical tower silo.

Trench Silos lined with Concrete.—In some cases trenches of the type indicated above have been lined with concrete. Excellent silage has been made in these, but in view of the very good results which can be obtained with a simple earth trench, it appears very doubtful whether the expense of lining with concrete is justifiable.

Recently introduced Continental Processes.—During the year 1932 much interest has been taken in this country in recently introduced Continental methods of making silage. A full description of the A.I.V. process, recently patented in Finland, appeared in the last issue of this *Journal*.[1]

Conclusions.—1. Ensilage is a very valuable means of providing succulent food for the winter use of farm animals.

2. The making of silage greatly reduces the risk of loss during a wet hay harvest. It also enables the area under roots to be reduced.

3. Of the various types of tower silos, those made entirely of reinforced concrete—walls, chute, and roof—if properly erected, are likely to be most durable and cost least in repairs. They may not be more costly than, or even as costly as, other types, especially if some of the work connected with their erection can be done by the farm staff in slack times. Tower silos are most likely to be permanently used when erected by owner-occupiers.

4. Satisfactory silage can be made without any appreciable capital expenditure, in stacks, clamps, and trenches. Of these the first two can be made without any preparation. In the case of trench silage a suitable excavation has to be made, but this may be used for as many years as desired. On the whole, if suitable precautions are taken there is less likelihood of undue waste in the case of trench silage than in the case of stacks or clamps.

[1] Vol. xv., No. 3, p. 252.

FURTHER EXPERIMENTS ON LEAF STRIPE OF OATS.

D. G. O'Brien, Ph.D., and R. W. G. Dennis, B.Sc.

Previous papers [1] [2] calling attention to the prevalence of the leaf stripe disease of oats in Scotland, and outlining methods for its control, have been published in this *Journal*. During the present season, work along these lines has been continued by the Plant Husbandry Department of the West of Scotland Agricultural College, and it is the purpose of the present article to supplement the earlier accounts in the light of later work.

O'Brien and Dennis [2] have already laid emphasis on the importance of reducing the rate of seeding where disinfected grain is used. In order to obtain definite information bearing on this question, the following experiment was laid down at Auchincruive in March of this year. One-tenth acre plots were drill-sown with Pure Line Potato oat at the following rates of seeding: 5 bushels per acre, untreated; 4, 3½, 3, 2½, and 2 bushels per acre, all disinfected with Ceresan. On none of the disinfected plots has leaf stripe disease become evident, while 22·8 per cent. infection was recorded on an untreated section. Adequate counts of the number of seedlings established within a given area, taken at random over each plot, have shown that for this variety, drill sown, 4 bushels per acre of disinfected seed give a braird equivalent to that obtained from 5 bushels per acre not disinfected.

Leaf stripe disease is particularly destructive to certain varieties of the "grain-producing" class. In an experiment with variety Yielder, sown at a rate of 6 bushels per acre, the disinfected section showed an establishment of 218 seedlings per unit area, compared with 170 on the untreated section. Of the latter, 30 per cent. were diseased. It is evident, therefore, that reductions in rate of seeding of 25 per cent., proportionate to that indicated for Pure Line Potato, must be practised with large seeded varieties, when disinfected.

Not only does treatment with an efficient disinfectant such as Ceresan eliminate disease and thus result in a better braird; it also imparts a stimulus to the development of the seedlings.

In experiments on a small scale in boxes, the effect of disinfection is shown by the earlier appearance above ground of the treated lot. Under field conditions it is a matter of common experience that the seedlings developed from disinfected grain grow and tiller more rapidly, and the resultant crop is commonly ready for harvesting 7 to 10 days earlier than that on untreated sections.

In the case of leaf stripe disease of oats it has been clearly demonstrated [1] that the infection of the seedling is derived from

[1] "Leaf Stripe or Yellow Leaf of Oats." D. G. O'Brien, M.A., B.Sc., B.Sc.(Agric.), and E. G. Prentice, B.Sc. *Scot. Journ. of Agri.*, vol. xiii., 272-84 (illus.), 1930.

[2] "Control of Leaf Stripe or Yellow Leaf of Oats." D. G. O'Brien, Ph.D., and R. W. G. Dennis, B.Sc. *Scot. Journ. of Agri.*, vol. xv., 39-45 (illus.), 1932.

the seedcoat, which became infected prior to harvest the previous year. On the seedcoat, the causal agent of the disease (*Helminthosporium avenæ*) may exist in two forms :

(*a*) As a thick-walled resting mycelium, spread over the surface of the husk.

(*b*) As spores adhering loosely to the surface.

Spores are comparatively rarely found on harvested grain, and there is no evidence that they play any important part in originating primary infection of the oat crop.

Resting mycelium, on the other hand, is always to be found in varying abundance, on seed harvested from an infected crop. Such mycelium is located mainly at the tips of the inner and outer palea, and it is from this situation that infection of the emerging shoot takes place. As the coleoptile grows out between the tips of the palea, it comes in contact on each side with the inner surface and edge of the boat-shaped outer pale. If mycelium of *H. avenæ* is present on the husk, and has been stimulated to develop by favourable conditions of temperature and moisture, then the emerging coleoptile will become infected at these two points of contact with the husk (Fig. 1). As the coleoptile grows up, successive regions pass the infective points, and the result is two narrow, brown, longitudinal lesions, extending one on each side of the coleoptile for its entire length. It is important to notice that from the first it is the shoot system which is attacked. The roots develop normally and, in the early stages at least, there is no difference to be detected between the roots of a healthy plant and of one parasitised by *H. avenæ*. In the event of heavy coleoptile infection under conditions favourable to the development of the fungus, the seedling involved fails to reach the surface of the soil. Investigation below the surface of any heavily infected field of oats when the plants are coming through, will reveal such specimens as illustrated in Fig. 2. These are characterised by elongated, contorted coleoptiles and etiolated first leaves, both marked by brown lesions from which *H. avenæ* can be readily isolated in the laboratory.

It is often stated by experienced farmers that leaf stripe appears in greater abundance in the case of untreated seed sown on land which had borne oats in the preceding year. This evidence may at first sight be held to indicate that mycelium of *H. avenæ* remains as a saprophyte growing in the soil from which an infected crop has been taken. Experiments to investigate the possibilities of the growth of the leaf stripe fungus on soil have been recently carried out by us. The results show that, while *H. avenæ* is capable of growing well on soil which has been thoroughly sterilised, and has become therefore comparable with an ordinary culture medium, it is quite incapable of growth on unsterilised soil. In other words, it is unable to compete with the normal saprophytic flora of the soil, and cannot be assumed to occur growing freely in ground which has borne a diseased crop. This

conclusion is confirmed by the following experiment. Portions of a culture of *H. avenæ* growing actively on sterilised soil were planted with disease-free oat seed under controlled conditions favourable to the development of leaf stripe. The culture fragments were placed on the same level as the oat seed but not in contact with

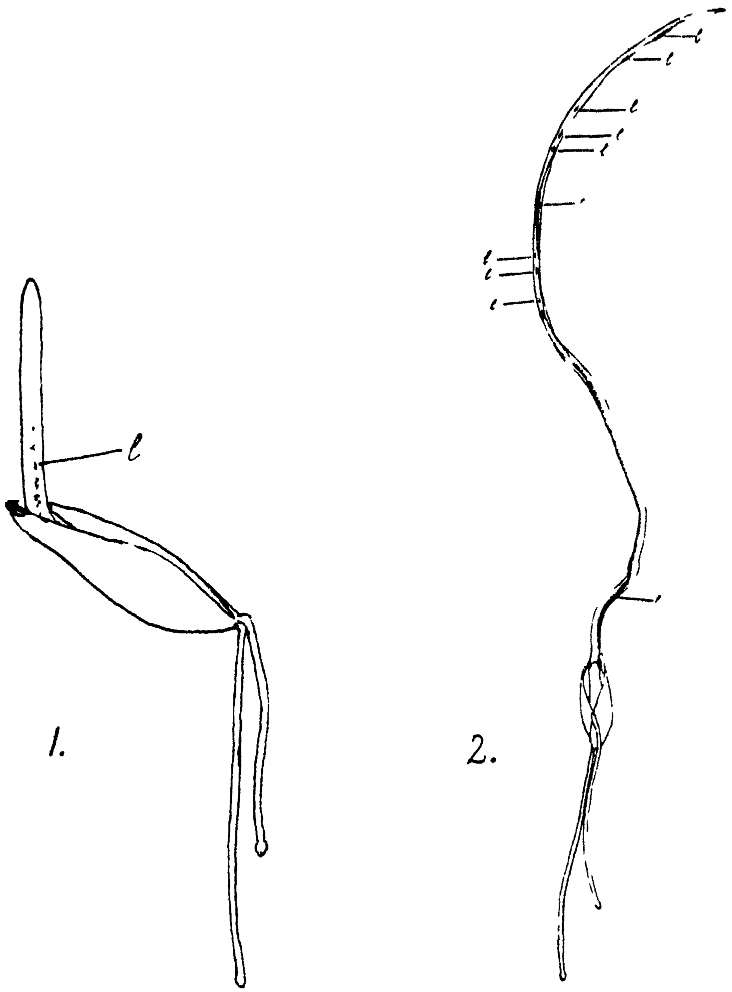

Fig. 1. Infection of Oat Coleoptile by Helminthosporium avenæ (l = Lesion).

Fig. 2. Contorted Seedlings showing Lesions (l) on Coleoptile and First Leaf.

them, so that to infect the seedlings, the fungus would require to grow through a short distance of unsterilised soil. No trace of disease resulted in the seedlings.

On the other hand, resting mycelium and sclerotia of *H. avenæ* can be found in abundance on stubble left from an infected oat crop, and are capable of passing the winter in such a situation as easily as on harvested grain. Mycelium of this fungus withstands temperatures well below the freezing-point of water. When such

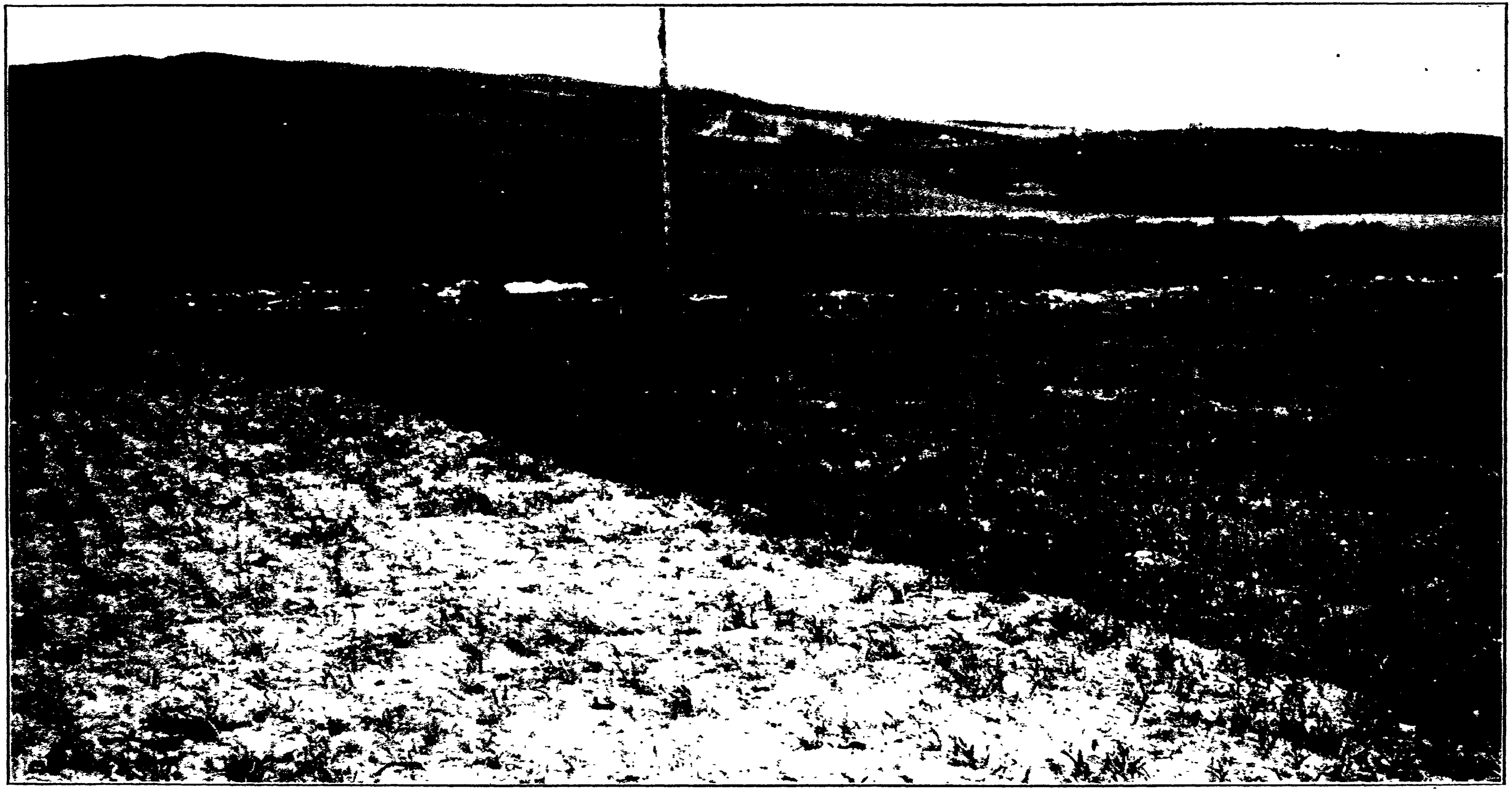

Plate I.—Oat Disinfection (Yielder), 1932. Right: Treated with Ceresan. Left: Untreated.

stubble is ploughed in, therefore, it obviously affords a ready source of infection if oats come in contact with it on the same land in the following year.

It is important to observe that leaf stripe attacks the oat plant at two sharply differentiated periods of its development :—

(*a*) The primary phase, extending from the coleoptile to the third leaf. Sporadic infection of the fourth seedling leaf may be recorded, but after this all trace of the disease as such usually disappears.

(*b*) The secondary phase. This appears usually in July, and attacks all the upper leaves and the inflorescences.

Primary infection develops by growth of the mycelium through individual plants, in which the disease originated from the grain as already explained. It is not spread from plant to plant by spores (*conidia*) to any appreciable extent in the field. Secondary infection, on the other hand, is spread rapidly by means of spores from plant to plant and from field to field, and may be expected to appear on all plants of an oat crop, whether previously healthy or not. More or less complete elimination of primary infection, by the use of a suitable seed disinfectant, will not protect an oat crop from secondary infection later in the same year. In this connection figures obtained in an experiment at Auchincruive in 1931 may be quoted. Control of primary infection by disinfection of the seed with Ceresan was very successfully carried out. Examination of the upper leaves of the plants in September, however, showed that all the plants, and 93 per cent. of the individual leaves were attacked by the secondary phase of leaf stripe. It follows, therefore, that it is not sufficient to disinfect seed one year, and save grain from the resultant crop, to sow untreated in the succeeding year. Such grain may be expected to be as heavily contaminated with mycelium of *H. avenæ* as if seed treatment had not been practised. It is essential that seed should be treated every year with an effective disinfectant such as Ceresan, if leaf stripe is to be controlled in the primary phase. As far as the obvious financial loss to the farmer is concerned, the primary phase is of course the more important of the two.

Weather conditions at harvest time undoubtedly exert an influence on the percentage infection of the ripe grain. Dry weather at the critical period tends to reduce the intensity of contamination, while a wet period favours the development of *H. avenæ*. Although the summer of 1931 was, on the whole, wet, yet comparatively dry weather prevailed over most of Scotland during the oat harvest. As a result, examination of the harvested grain shows a smaller percentage infected with the leaf stripe fungus than was observed after the wet harvest of 1930. When this is the case, it is clearly futile to expect such marked results in increase of braird by disinfection of 1931 seed as were obtained when using the heavily diseased seed of 1930 harvest. Nevertheless as the figures already quoted show, the results of seed disinfection this year, though not so spectacular as in the spring of 1931, still

demonstrate the value of the practice in an average season. In many cases, however, where heavily-diseased seed was used, results of disinfection were as marked as in 1931, as shown in Plate I.

Examination of seed samples submitted from various localities in the North, Midlands, and South of England, has indicated that leaf stripe of oats is by no means to be regarded as a peculiarly Scottish disease. None of the samples referred to proved completely free from infection, percentages varying from 4 to 72 being recorded, varying according to the locality and variety concerned.

There is, as might be expected, evidence that all varieties of oats are not equally susceptible to parasitism by *H. avenæ*, and it is hoped to publish details bearing on this aspect of the problem in due course.

It is a matter of common mycological experience that species of the genus Helminthosporium, to which the leaf stripe fungus belongs, are liable to exhibit marked variation in their morphological and physiological characteristics. *H. avenæ* is no exception to this rule. Not only do individual strains exhibit variation under controlled cultural conditions, but markedly different types of the same fungus may be isolated from diseased plants originating in different districts.

In conclusion it may be pointed out that, while Ceresan has given the most satisfactory control of this destructive disease up to the present time, other dusts are constantly being tested by us in order to determine their efficiency in this respect. The active principle in Ceresan is well known to be an organic derivative of mercury, and it is to be expected that with the accumulation of experience other mercuric compounds may be found to yield as good or better results than Ceresan. The ideal disinfectant is, of course, one which, while cheap, harmless to the operator and easy of application, yet gives complete control of seed borne diseases, and, at the same time, stimulates the growth of the resultant crop.

WEED CONTROL BY SULPHURIC ACID SPRAYING IN FRANCE.

D. Skilbeck and H. G. Coles,

School of Rural Economy, University of Oxford.

The control of weeds by sulphuric acid in France has passed beyond the experimental stage, and is an accepted general practice in many districts of the country. With a view to its possible application in this country, a short survey was carried out by the writers in France, and some preliminary trials were made in this country during the course of the summer of 1931 near Oxford. Unfortunately, the exceptional weather conditions prevailing at harvest-time, and the fact that the spraying of the crops was unduly delayed owing to difficulties in procuring a suitable

spraying machine, made it impossible to make satisfactory quantitative estimates of the effect of the spray on the crops. The use of sulphuric acid spraying in France is mainly confined to the cereal crops, though some experimental work has been done on its application to grassland, and to the general control of annual weeds. Weeds with strong underground stems are naturally unaffected, or, at the most, merely checked.

The most remarkable aspects of the French practice are the concentration of the solutions which are used, and the insignificant damage caused to the cereal crops. Solutions up to 20 per cent. by volume of acid can be used on wheat in spring without damage to the crop, though solutions of such high concentration are not used in general practice. The strength of the acid depends largely on the weeds which are to be killed and to a less degree on the crop in which they are growing, and on the time of year at which the spraying is carried out. Dealing with the two latter points, it is customary to use rather weaker solutions on oats (winter and spring varieties), on barley, and on spring wheat, than on winter sown wheat. The earlier the spraying is done, as a rule, the weaker the solution of acid used. Winter spraying is not undertaken to any great extent in Northern France, but in the central and southern Departments, where the climate permits of winter germination of many of the weeds, it is quite customary to spray in midwinter. In the north, spraying is usually done from March to early May, but this will vary considerably with seasons, for it is useless to spray until the weeds have reached, at any rate, the cotyledon stage. The common practice is to top dress with nitrate of soda about two weeks before spraying with acid. This dressing is never applied after the spraying has been completed, but it is sometimes applied in solution with the sulphuric acid.

The strength of the solution needed to destroy different types of weeds may be classified as follows :—

5 to 7 per cent. by volume.	Charlock	= *Brassica sinapis.*
	Wild Radish	= *Raphanus raphanistrum.*
	Feverfew	= *Matricaria chamomilla.*
	Chickweed	= *Stellaria media.*
	Speedwell	= *Veronica agrestis.*
	Groundsel	= *Sinecio vulgaris.*
10 to 12 per cent.	Poppy	= *Papaver rhoeas.*
	Cornflower	= *Centurea cyanus.*

These weeds are completely destroyed. Corn Crowfoot (*Ranunculus arvensis*) is severely checked, and in certain cases destroyed, but there is considerable difference of opinion about the effect of sulphuric acid on this weed. On the trial plots in England it was completely annihilated by a 10 per cent. solution. Thistles, although not killed, are very severely checked, and it is claimed that spraying weakens the plant very much and greatly reduces seeding. The gramineæ (*e.g.*, couch grass and black bent) are untouched by the solution.

With regard to the effect on soils much more data will be required, but the process in France is carried out equally effectively on acid and on calcareous soils, and also on soils of varying mechanical composition. Liming is carried out when necessary, but seldom more frequently than is consistent with the usual agricultural practice of the country.

It is considered essential for the success of the treatment that no rain should fall until three hours after spraying, though it is most effective when the crops are moist with dew so that the solution is immediately distributed over the whole leaf surface. The actual process of destruction is more rapid and complete on dry days. Withering of weeds is noticeable after about a quarter of an hour under good conditions, and complete withering should be accomplished within the day. Copper sulphate, to be completely effective, requires at least 24 hours' fine weather after spraying.

The effect of the acid on the cereals is remarkable. Almost immediately after spraying the outer leaves are attacked and begin to redden, but the central growing shoot is unharmed, and crops which have been sprayed, although appearing practically killed, will show little or no sign of damage after two weeks, though it will be often quite possible to distinguish treated from untreated plots by the check in the growth which has been caused by the spray for some considerable time. This check, observable throughout the growing period of the crop, may delay harvest by two or three days. Tillering capacity is increased by the treatment, but how far increased spring tillering is responsible for larger corn yields is a problem which still needs further investigation.

In addition to the control of weeds, the sulphuric acid treatment considerably reduces "foot rot" in corn. This is a common complaint in France, and causes considerable loss to the farming community as a result of the corn becoming badly laid. The stem weakness is due to damage to the base of the plant caused by fungi, mainly *Ophiobolus Graminis* and *Leptosphœria herpotrichoides*. These fungi are not so common in Britain as they are in France, but there is a possibility that they cause more damage than is generally supposed. Sulphuric acid does not destroy the fungi when once they have attacked the corn, but it lessens the risk of infection if sprayed early enough. Special research on this aspect of the spraying is being undertaken by Professeur Foex at the Institute of Plant Pathology at St Cyr. Using a 12 per cent. solution, he is endeavouring to discover the best time of year to spray against "foot rot."

According to the French experimental data at harvest-time there is said to be a noticeable but not important reduction in the weight of the straw. Yields of grain are increased both in quantity and quality, but unfortunately it was impossible to make accurate measurements on the English plots in order to confirm these statements.

In addition to the control of weeds and injurious fungi it has been said by the French authorities that sulphuric acid acts also as a fertiliser on the soil, but little seems to be known about how it acts in this way or how it acts as a flocculating agent on clay soils. After the corn has recovered from the initial check there is always noticed a deeper green colour on the treated parts of the field than on the untreated parts. The colour, which would normally be associated with a dressing of nitrate of soda, is quite observable about three weeks after treatment, even where spraying has been carried out without any additional nitrogenous dressing. Careful field and laboratory research would, however, show definitely how sulphuric acid would act as a fertiliser, and it should be possible to discover the types of soil which would benefit most from its application. The importance of sulphuric acid as a flocculating and fertilising agent in addition to its importance as a means of weed and fungi control, makes it even more essential to gain detailed information with regard to its action on the soil.

The dilution of sulphuric acid is supposed to be a process accompanied by some difficulty and danger, but actually the mixing of the solution as performed in the field on French farms is simple and safe. The process is carried out by farm-hands, and an accident is said to be unknown. Precautions are taken, however, by careful instructions to the men, and by the use of old and thick clothing and of wooden shoes. Two methods of mixing are employed, mixing the solution in wooden tubs and mixing it in the spraying machine itself. In the former method the carboy of acid is fixed in an iron tipper, the acid is then poured out carefully into a copper pail, and the contents of the pail are poured into a wooden tub containing approximately the right volume of water. There is a small rise in temperature in mixing, but by continuous stirring with a wooden stick this is minimised. The mixture is then pumped into the spraying-machine. In the second method the barrel of the spraying-machine is filled with water to a known volume and then acid is drawn into the barrel directly by suction from the carboy. Mixing is carried out by circulating the whole through the pump and back into the barrel. The usual type of sprayer in use in France is the pressure-sprayer, as it is absolutely essential to spray a sulphuric acid solution in a very finely divided form. The pressure is derived either from the road-wheels or by a separate motor-pump. In England, the use of a new Danish sprayer has proved satisfactory. The principle of this machine is that a thin stream of the liquid falls on to a quickly revolving disc of special design, and this gives a very finely divided spray. The barrels of the sprayers are usually made of pitch pine, which is only slowly attacked by the acid; but more recently iron barrels have been substituted with an inside coating of acid-resisting enamel. The degree of purity of the acid employed varies; in France, in order to save transport, it is general to use the purest acid, but lower grades are sometimes used, though they are generally more costly per unit.

It has been recommended that preliminary trials should be made before actually spraying a whole field, but such is the resistance of the cereal crops to the acid that there is little or no danger of damage except from very excessive over-spraying, and such trials were practically never seen in France.

The cost per acre of the treatment in this country is difficult to compute, and bound to be very variable. The cost of the acid varies considerably, according to the freightage charged on rail, as at the present time rail-rates on sulphuric acid are very high. The cost of the acid (77 per cent.) is about 45s. to 50s. per ton, with additional charges for carboys and rail which may amount to as much as 30s. to 40s. per ton. Allowing one ton of acid to 20 acres, the actual cost of the acid would be about 3s. 6d. to 4s. 6d. per acre. In addition, there is the annual depreciation of the machine and the cost of carting the requisite water to the field. With a pressure sprayer it is possible to cover some 25 acres a day with one horse, a carter, and a labourer to mix the acid. Estimating very roughly, the total cost should be about 6s. to 9s. per acre—a figure which is comparable to actual costs incurred in France.

In conclusion, the authors wish to place on record their indebtedness to the National Sulphuric Acid Association, Limited, at whose instigation this survey was undertaken, and by whom all the expenses involved were kindly defrayed.

FERTILISERS IN WESTERN CANADA.

J. D. Middlemass, B.Sc.

Introduction.—Within recent years prairie farmers in Western Canada have had reason to revise their opinion regarding the fertility of their farm land which, agriculturally speaking, has been under cultivation for a comparatively short period. Not only has it been assumed that the fertility of the virgin prairie was boundless, but, until recently, it has been considered that the use of fertiliser was not necessary, and almost certainly not of economic importance.

Prior to 1928 scattered experiments at Government experimental stations had shown that only slight benefit had accrued from the broadcast application of low-grade commercial fertilisers on small test plots of cereal crops, and that the results obtained were only of slight economic significance. In that year an extensive co-operative programme of investigation was begun by Provincial and Dominion Departments of Agriculture, private farmers, and industrial concerns, the whole programme being sponsored by the Consolidated Mining and Smelting Company of Canada, Limited, of Trail, British Columbia, and directed by Dr R. E. Neidig, Director of Agriculture of that Company. Not only were experiments conducted on small plots at Government

stations, but large-scale field trials were arranged, in order to demonstrate to the actual farmers both the economic results obtainable and also the best cultural practices to ensure the most efficient use of fertiliser.

Methods Used.—In the year mentioned, and the two succeeding ones, careful experiments were conducted on these lines at over two thousand centres with most successful results. Not till then was the commercial product placed on the market. From the evidence collected, it was clearly seen that, not only was the use of high analysis fertiliser essential, but that, for cereal crops, the only method of application by which good results could be uniformly obtained was by drilling in the fertiliser with the seed at the time of sowing.

Broadcasting of the fertiliser on grain crops repeatedly failed to give results, and drilling in the fertiliser with the seed both economised labour and ensured the most efficient use of the fertiliser. This agrees entirely with Australian practice, where broadcasting is rarely used as a means of application.

It should be noted that fertilising practices adopted in various countries are seldom applicable as a whole in others. In the major industry of grain-growing in Western Canada, crops are grown under semi-arid conditions, with a short season, and with little recourse to any extensive system of rotational cropping. Moist conditions, long growing seasons, and crop rotations are all factors influencing fertilising practices.

In some instances farmers in Western Canada look on fertilisation as an admission that their land is losing fertility, but opinion is now becoming more enlightened. It is, however, essential to impress on those using fertiliser that the application of fertiliser does not relieve them from the responsibility of using the best cultural methods.

Soil Fertility and Soil Analysis.—Throughout the experimental programme continued evidence was forthcoming that farmers and others placed implicit faith in soil analysis as a guide to the response of that soil to fertiliser. While it is true that soil analysis reveals the extent of the potential plant food supply, it can neither reveal the rate at which this plant food is made available to the growing plant nor the amount of the constituents available at any given time. It is essential, when investigating fertiliser problems, that soil be considered as dynamic in character and not static, and field trials are the surest method of determining the response of a soil to an application of fertiliser.

Soils of Western Canada.—Throughout the programme an extensive soil survey was carried out, and this showed that prairie soils, in general, were relatively low in total phosphorus, high in total potassium, and varied in their nitrogen content. The greatest responses were obtained from the application of fertilisers containing phosphorus, or nitrogen and phosphorus, applied respectively in the form of triple superphosphate (containing 43 per cent. available phosphoric acid, P_2O_5) and

ammonium phosphate (containing 10 per cent. available nitrogen, N, and 48 per cent. available phosphoric acid, P_2O_5).

"Availability" of the plant food in the fertiliser is of great importance, as it is essential to push the crop forward in the early spring when the soil is cold and when bacterial activity has not advanced sufficiently to break down plant food constituents and render them available to the growing crop.

During the experimental programme repeated evidence was found that, even though some soils showed a high total analysis of plant food, the application of small quantities of fertiliser carrying immediately available plant food gave highly satisfactory results.

As can be realised, barnyard manure is of little importance in the wheat belt of Western Canada, as so little of it is produced. Summer fallowing is used extensively to conserve moisture and control weeds, and the practice of green manuring is extending. In this connection good results were obtained both by fertilising the green crop before ploughing it down and also by fertilising the succeeding crop.

Owing to the lack of any extensive rotational cropping, fertilisation in Western Canada has been considered more in the light of feeding a crop rather than fertilising the soil, though excellent residual effects have been noted from previous years' application.

Results Obtained.—Careful records of the fertiliser programme showed a remarkable consistency in the results obtained over a wide range of soil types and climatic conditions. In all trials cultural practices on the fertilised and unfertilised portions of the field were the same, and the large-scale demonstrations were laid out for the full length of the field (in some cases extending to one mile) in order to observe the difference on the soil variations in the same field.

Early in the season a much more rapid growth was apparent in the young grain crop, accompanied by a healthier and greener colour (visible in some instances from two to three miles distant). This growth was accompanied by a stronger root development of the fertilised crop, with the establishment of a large feeding range both for plant food and moisture.

Examination of the fertilised grain showed that tillering had increased, and frequent counts showed that, where the unfertilised crop would have three to four tillers from one kernel, the fertilised would show from five to seven or even more. In addition, farmers would frequently comment on the uniform stand of the crop and the absence of patchiness, this factor being of great importance where combine harvesters were used.

In line with Australian experience, it was found that fertilisation assisted in the conservation of the moisture, not only by covering the bare soil with a rapidly-growing crop, and thus avoiding evaporation, but also by lowering the transpiration ratio. In other words, it was found that less water was required to build

FIG I.—Showing the more advanced, vigorous growth of a fertilised wheat crop as compared with the patchy, uneven growth of the unfertilised drill width in the centre. Cutworm damage is in evidence in the unfertilised strip.

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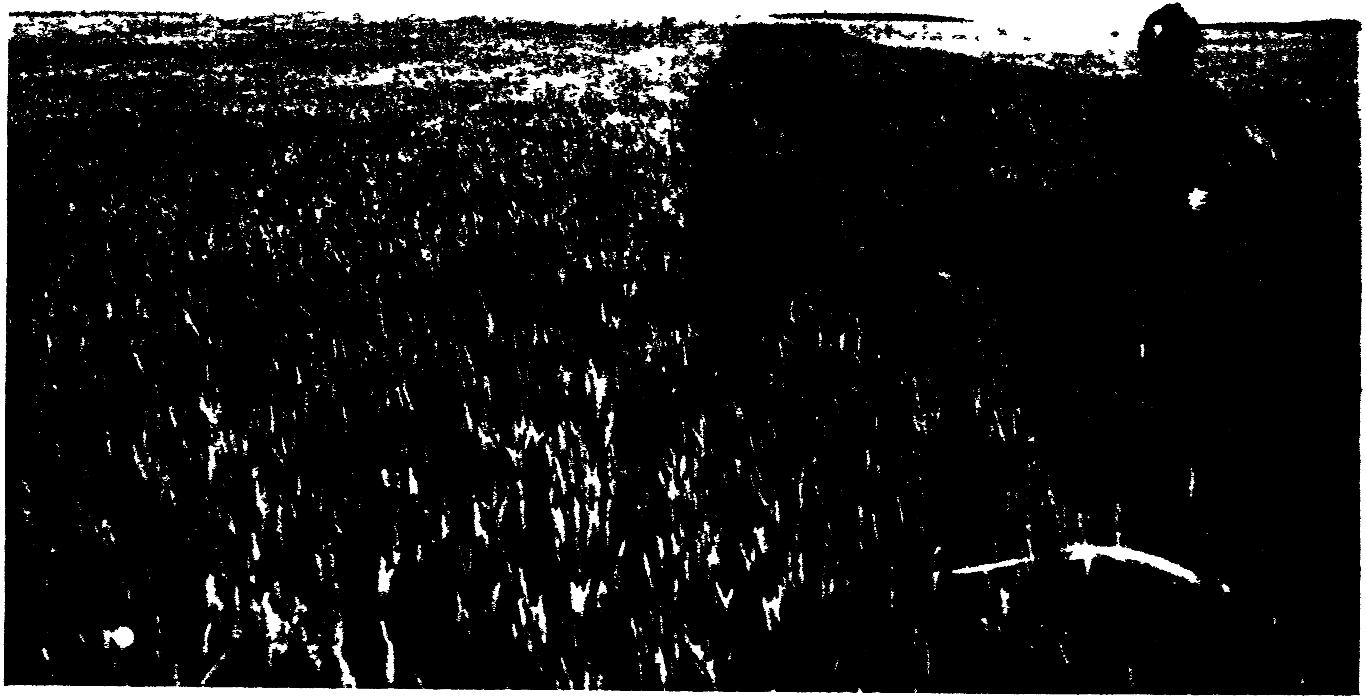

FIG. II.—Showing the effects of fertiliser in obtaining ten days' earlier maturity on a large wheat crop in Northern Saskatchewan, where early maturity is of great importance

Fig I.—Showing the more advanced, vigorous growth of a fertilised wheat crop as compared with the patchy, uneven growth of the unfertilised drill width in the centre. Cutworm damage is in evidence in the unfertilised strip.

up a pound of dry matter in a crop correctly fertilised than where the plant food was insufficient or unbalanced.

Throughout the programme, it was found that by drilling in the fertiliser with the seed the quick crop growth induced tended to smother weeds which, growing between the rows, were denied the benefit of fertiliser. This was frequently commented on by farmers, who obtained much less weed dockage when hauling their grain to the elevators.

In a similar manner the vigorous, healthy growth of the fertilised crop tended to minimise losses from soil drifting, plant diseases such as root rot, and also from insect pests such as cutworm and wireworm.

Possibly the most outstanding result was the remarkable advance in maturity shown by fertilised crops, which were found to ripen seven to ten days earlier than the unfertilised. In districts where frost, rust, and damp weather are liable to occur at harvest time, this factor is of tremendous importance, as it enables the harvesting operations to be carried out sooner and a higher grade of grain to be marketed. Gains of from three to four grades in the fertilised grain were quite frequent where the unfertilised crop had been damaged by frost or rust.

Careful records of increased yields obtained show that average increases over a period of years of six to eight bushels per acre are not uncommon, while increased yields in individual years of eight to ten bushels, and even higher are frequently obtained. Commercial users are, however, realising that it is the combination of beneficial factors that gauges the efficiency of fertiliser, and that the increased yield is only one of these factors. Even with the present low grain prices the economic returns from the use of fertiliser show a comfortable margin.

High Analysis Fertilisers.—Owing to the saving in freight and handling charges, and also to the satisfactory results obtained, the use of high analysis fertilisers in Western Canada is extending rapidly. However cheap per ton the price of low-grade fertiliser may be, the cost per unit of plant food is much higher in this form than when high analysis fertiliser is used, by the time the fertiliser has been laid down on Western Canadian farms.

The two fertilisers which were found to give the most satisfactory results were triple superphosphate and ammonium phosphate, though investigations are still being carried out to determine the suitability of other types of fertiliser on various soil types and under various climatic conditions.

Rates of application of these fertilisers that have been found to give good results when correctly applied, vary from thirty to sixty pounds per acre of triple superphosphate, and twenty to fifty pounds per acre of the more highly concentrated ammonium phosphate, depending on the soil type and climatic conditions. The costs to the farmer, at these rates, approximate 75 c. to $1·50 per acre.

Methods of Application.—At the outset of the programme

special combination grain and fertiliser drills were brought in from Australia, and, in addition, numerous experiments were laid out by broadcasting fertiliser by hand. Results soon showed that application of the high analysis fertiliser was most efficiently and economically made by the use of the special drills, though special modifications had to be made to handle the low amounts of fertiliser applied per acre and to ensure its even distribution. Latterly special fertiliser attachments have been developed to affix to ordinary grain drills in order to convert them to combination drills. The practice of mixing both the grain and fertiliser and sowing the mixture from an ordinary drill was found to be quite unsatisfactory, owing to uneven application and excessive wear on the drill.

Summary.—Extensive experiments on the use of fertiliser on cereal crops in Western Canada since 1928 have revealed the following facts :—

1. Broadcasting of fertiliser on the crops mentioned is seldom an economic practice.
2. The most efficient use of the fertiliser is made, and the most successful results obtained, when the fertiliser is drilled in with the seed at the time of sowing.
3. Good results follow the use of high analysis fertilisers, particularly triple superphosphate (30-60 lb. per acre) and ammonium phosphate (20-50 lb. per acre).

SECTIONAL GRAZING AND MANURING OF GRASSLAND.

E. Wyllie Fenton, M.A., B.Sc.,
Edinburgh and East of Scotland College of Agriculture.

Sectional grazing and manuring are now practised in many parts of Britain, and with the extension of the method more information is available than could be obtained in the earlier stages of this practice. As might be expected, examples not in agreement will sometimes occur, and it is always a matter of more than passing interest to know the reason for these discrepancies.

What makes the problem more difficult is the fact that grassland is a mixed vegetation which shows marked fluctuations in flora during the growing season (9), as well as differences resulting from the type of weather prevalent during any particular year. Of paramount importance also is the nature and method of grazing and the general treatment of the pasture, while soil conditions, exposure, and altitude cannot be ignored (6). The age and nature of the grassland, climate, soil, temperature, and the amount of sunshine are all factors of importance. When these many interacting factors are taken into account, it is not surprising that results are not always in agreement.

To take one point, in some cases where grassland has been

sectionally manured and grazed, there has been a diminution of keep after the first year. This has occurred at the Experimental Farm of the Rowett Research Institute, Aberdeen (18). As no details have so far been published, it is not possible to discuss the factors at work.

In contrast with this experience, we found that in Devonshire, both on a good loam (Tiverton) and also on a rather dry soil exposed to the heat of the sun (East Down, Newton Abbot), there was a marked increase both in total yield and in amount of wild white clover (8). In the latter case it had not decreased from 1927 to 1929. Further, on a visit to East Down in September 1931, we found that in spite of the continuance of sectional grazing and manuring since 1927, instead of a decrease in the two plots examined, there was an increase of wild white clover. The wet season (1931) may, of course, have accounted for part, but not for the whole of the increase. In this connection, we may add that during the summer of 1931 there was a marked increase of wild white clover on some of the semi-natural pastures at Boghall Experimental Farm, Edinburgh. This was due to the continued rainfall throughout the summer. In a normal year these high lying pastures tend to get badly dried out, which affects clover very adversely. The importance of adequate moisture has been pointed out by Continental workers (7). Temperature is also a very important factor in the growth and spread of wild white clover.

Scorching of wild white clover is one of the difficulties that may arise from frequent applications of sulphate of ammonia. Near Tiverton (Devon) we never found any trace of scorching on the leaves of wild white clover, even in warm weather. At East Down we did find on one occasion that the clover leaves were badly scorched and on another occasion slightly scorched (8). This effect disappeared after rain. It is quite evident, however, that if repeated scorching occurs, wild white clover is bound to be depressed and will be unable to compete successfully with the other plants present. Further, the scorching, if severe, will lead to less surface moisture being retained in the soil and adversely affect clovers and possibly also the grasses. It is quite conceivable that in districts of low summer rainfall and prolonged hot dry spells this may be one of the chief causes of the observed decrease in wild white clover (4, 21). We have shown in one district of Devon that it is impossible to form a good pasture or to obtain keep for stock unless there is a reasonable quantity of wild white clover (9). The same is true for certain areas of Scotland (11).

The seasonal fluctuations of the species present in the pasture must also play a part according to the stage of the fluctuation present when the sulphate of ammonia is applied. Again, in experimental work, where cutting takes the place of grazing, a very appreciable error is introduced (20, 21, 14).

We tentatively suggested the possibility of applying the

sulphate of ammonia in two half doses in place of each application, in order to reduce any scorching effect (8). Woodman has recently suggested the application in one large dose at the commencement of the season (21). This proposal is worth trying. It may perhaps be questionable whether sulphate of ammonia should be added so often as is the general practice in this method of grazing. Occasional applications might give almost equally good results and cause less interference with the flora of the grassland. As already noted, another doubtful point is the effect of applications of sulphate of ammonia to a soil which is dry and tends to be dry during the warm parts of the year, and the subsequent effect on wild white clover.

The aim of the method is to increase the value of the keep for stock. Chemical analysis may show excellent results, but it takes no account of palatability or digestibility (5). The final test is the number and condition of the stock which any grassland will successfully support. This may be estimated in terms of meat or milk (19), or, best of all, by financial figures. Now it is surely of significance that the best pastures, as shown by Fream (12, 13), Carruthers (3, 4), Armstrong (1), and others in England, and M'Alpine (15,16) and Fenton (10) in Scotland, are those where there is a high proportion of wild white clover plus perennial rye grass. In permanent pasture or long leys the value of the pasture seems to decrease with the decrease of wild white clover and perennial rye grass. The high proportion of lime in wild white clover is not without significance (2). It may be that under certain soil and climatic conditions, applications of sulphate of ammonia are being overdone either in number or in quantity; in some cases it may be both. There is no doubt that soil, climate, and other conditions play a large part in the results so far obtained (6). Such intensive manurial treatment may lead to an ecological phase in the grassland where the equilibrium of the flora is upset, and retrogression may ultimately be the result. Time alone will reveal whether this is a danger.

Cutting, as carried out experimentally, is not the same as grazing (20), and this may to some extent explain the depression of the clover recorded. Even then, much will depend on the height and thickness of the herbage before cutting. If dense and of some height, it will adversely affect wild white clover.

What is most wanted is large-scale experiments to test the stock-carrying capacity of grasslands under this system in different parts of the country, with careful costings. The financial side is the important one, for the farmer finally judges success or failure by examination of the balance-sheet.

In making this suggestion we do not criticise for a moment the extremely valuable information which has been revealed on the chemical side, but the indiscriminate practice of these methods generally might in many cases lead to unfortunate results. There are cases where sectional grazing and manuring have not been too successful. In some instances this was due to lack of sufficient

control of the grazing animals, and in others to the high initial cost of fencing and an adequate water supply, or to the apparent unsuitability of soil and climatic conditions. Further, there is a great danger that the grassland is treated too much according to time-table. Is it always necessary to apply sulphate of ammonia after each section is grazed down, as is frequently done? The optimum quantity of sulphate of ammonia may differ widely on different soils and under different climatic conditions. The chief factors in the problem are the plants and the animals, and in our present state of knowledge they cannot be controlled by exact methods. In biology there is, so far, neither the finality nor the precision of mathematics, physics, nor even chemistry. For that reason it seems to us that, taking all the facts into account, we must proceed with extreme caution or await further information. The gradual loss of wild white clover, and doubtless of other legumes if present, would in good permanent pastures be a warning or a danger signal. We do not suggest there should be a very large proportion of wild white clover. Even where there is a large proportion of ground covered by wild white clover, it is often merely a passing phase, and the grasses will soon largely replace the excessive amount of clover (22). We have shown that this occurred where grazing was carefully controlled (9). Careful management is essential. We are in agreement with Nuding (17), that in such matters the chief point is to keep a watch on the vegetation and use that as a guide in deciding the treatment. Where depression of wild white clover is evident, it will at least be a safe criterion till further information is available.

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THE ARTIFICIAL LIGHTING OF POULTRY HOUSES.[1]

Professor RAYMOND T. PARKHURST, B.Sc., M.Sc.

National Institute of Poultry Husbandry, Newport, Salop.

CAREFULLY conducted experiements at the National Institute of Poultry Husbandry and elsewhere, as well as extensive observations on large numbers of fowls kept in both commercial and farm flocks, have given convincing evidence of the possibilities of increased revenue to those poultry keepers who will make use of artificial lighting in their poultry houses. Artificial lighting is not common in Great Britain. With the wider distribution of electricity from the mains, there is no logical reason why a majority of the poultry keepers should not adopt the practice.

Increased food consumption is the primary object of artificial lighting. Experiments seem to indicate that wherever the daily hours of sunlight are less than twelve it is worth while considering artificial illumination. The use of lights has not proved beneficial in Southern California or Kenya Colony according to reports received from these places. The short days of winter here, however, do not allow the fowls sufficient time to consume enough food for maximum results. The additional food consumption brought about by supplying extra light tends to keep the fowls in proper physical condition and body weight, and results in an increase in winter production of eggs. As the price of eggs is highest during the winter months, a greater income results. There should be increased profits, provided the cost of supplying electricity is not excessive.

Experimental Work.—Until recently it has been necessary to depend to a considerable extent upon American investigations to guide us in the practice of artificial lighting. Experiments on this

[1] This article is based on a paper read at the Conference on Electrical Research in Agriculture, March 1932.

problem were started at the National Institute of Poultry Husbandry in 1927, and are still in progress.

In the 1927-28 experiments, two pens were used. Each pen was 20 feet square, similarly lighted, ventilated, and equipped, except for the electric-lighting fixtures. Pen No. 1 was equipped with two 40-watt gas-filled electric lights 10 feet apart and 6 feet from the floor. Each lamp was placed in an aluminium-painted reflector, 16 inches in diameter and 4 inches deep. The light switch consisted of an alarm-clock so arranged that, when the alarm sounded, its winding arm threw over a tumbler switch and made contact at the desired time. The circuit also contained a meter to register the numbers of units of electricity used.

The experiment started on 1st October, and the lights were first used in Pen No. 1 on 28th October, four weeks later. The lights were gradually increased so that the fowls did not receive the maximum amount of light until the end of the first week. Throughout the winter months, Pen No. 1 received artificial illumination from 4 a.m. until daylight. The lights were gradually eliminated from 16th to 27th March. Each pen contained 120 Single Comb White Leghorn pullets selected from chickens hatched on 10th May. The pullets, which were late hatched and rather immature at the time the experiment started, were fed on both scratch and mash. Further details of the experiment are given in the National Institute of Poultry Husbandry Bulletin No. 6.[1] The lighted pen gave a higher percentage production throughout the period that lighting was in operation. For the winter months, the 120 pullets under lights laid 950 more eggs than an equal number of pullets without lights. For the 48-week period, the lighted pen laid 1086 more eggs than the unlighted pen. The lighted birds consumed an average of 3·72 oz. of food per day and the unlighted pen 3·47 oz. The margin per bird of income over food and lighting costs was 14s. 7d. in the case of the lighted pen, and 13s. 3d. for the unlighted pen, a difference in favour of the lighted pen of 1s. 4d. per bird. The cost of lighting pen No. 1 at 7d. per unit was 2d. per bird, 34 units being used in the course of the experiment. Subsequently one 60-watt gas-filled lamp and a dispersive type reflector (Mazdaluz X1028, diameter 10 inches, height 5½ inches) was used in the centre of the 20 feet × 20 feet pen instead of the two 40-watt lamps and the home-made reflector, with equally good results.

In order to compare different systems of inducing extra food consumption, six pens of April-hatched Single Comb White Leghorn pullets were started in an experiment on 2nd September 1930. The first 48-week period ended 3rd August 1931. The experiment is still in progress.

Each pen is similar in every way except for the lighting equipment. The birds were confined to the house from 14th October 1930 to 1st April 1931.

[1] This bulletin can be obtained free by writing to the National Institute of Poultry Husbandry, Newport, Shropshire.

The variations in the methods of lighting and feeding were as follows :—

Pen No. 1. "Evening lunch" system. The lights were switched on at 9 p.m., dimmed at 9.45, and out at 10 p.m.

Pen No. 2. "Morning" lights. The lights were switched on at 4 a.m. and off as soon as it was light enough for the fowls to see to eat.

Pen No. 3. "Morning and evening" lights. At 5 a.m. the lights were automatically switched on, at daybreak were switched off, at dusk were switched on again, were dimmed at 6.45, and were switched off at 7 p.m. This arrangement gave a fourteen-hour day.

Pen No. 4. "Special mash." This pen received a more highly concentrated mash which, with a low food consumption when no lights were given, would enable a larger amount of digestible protein to be assimilated.

Pen No. 5. has a dim light (20 watts) burning all night.

Pen No. 6 was the control pen with a standard ration and no lights.

The lights were controlled automatically and came on gradually from 7th to 14th October 1930, and were gradually discontinued from 25th March to 1st April. A Venner poultry time-switch was used in Pen No. 1 for the evening lights, the morning lights in Pen No. 2 were operated by a home-made alarm-clock switch ; a Nathan & Allen switch was used in Pen No. 3, and a Venner time-switch in Pen No. 5. The latter two switches had solar dials which automatically turned the lights on at one hour before dusk, and off at one hour after daybreak, in addition to their other operations.

Methods of Feeding.—Pens 1, 2, 3, 5, and 6 received the standard mash, and Pen 4 a special mash.

The all-in-one method of feeding was employed. No grit, oyster shell, or green food was given in addition to the mash. A wet mash was fed daily, during the winter period, to Pens Nos. 4 and 6 at 4 p.m., and pens 1, 2, 3, and 5 after dark between 8.45 and 9 p.m.

The results show that the value of lights lies primarily in the increased production achieved during a period in which the prices are higher. The production for the 48-weeks period was actually less in the all-night lights pen than in the two unlighted pens. Winter production was, in every case, greater in the lighted pens than in the unlighted ones. The morning and evening lights pen averaged about 10 per cent. better than the unlighted pens for the yearly production.

The experiment confirms the previous experimental work that shows striking increases in food consumption by the use of lights. For the 48-weeks period, the total food consumed was about 4 lb. more per bird in the morning lights pen than in the control (unlighted) pen.

All the pens showed gain in average weight. The mortality

was excessive in all pens, but was not in any way associated with the lighting, as it was equally great in the unlighted and lighted pens.

Table No. I. summarises the results of the experiment and contains a great deal of useful information concerning production, consumption, income, and costs.

TABLE I.

Summary of Averages per Bird for 48 *Weeks.* 1930–31.

Pen No.	1	2	3	4	5	6
	Evening Lunch.	Morning Lights.	Morning and Evening Lights.	Special Mash.	All Night Lights.	Control No Lights.
Income	£1 0 1	£0 19 11¼	£1 2 1	£0 17 5	£0 18 7½	£0 17 2½
Food Cost . . .	6 7¼	6 6	6 8½	6 8¾	6 4	6 2
Margin over Food Cost .	13 5¾	13 5¼	15 4½	10 8¼	12 3½	11 0½
Cost of Lighting . .	1¾	4	7¾	—	10½	—
Margin over Food Cost and Lighting . . .	13 4	13 1¼	14 8¾	10 8¼	11 5	11 0½
Egg Yield . . .	167·6	168·0	183·4	152·2	148·5	154·8
Yearly percentage Production . . .	49·87	49·99	54·58	45·31	44·19	46·07
Average Egg Weight, drams. . . .	31·4	31·6	31·2	31·8	31·6	31·4
Percentage of First Grade Eggs, 2 oz. and over .	50·3	52·4	46·8	58·1	55·6	50·7
Total Food Consumption in lb., oz.	75·13	74·11	77·4	72·5	72·12	70·12
Average daily Food Consumption in oz. . .	3·61	3·56	3·68	3·44	3·46	3·37
Average Body Weight, Beginning of Exp., in lb., oz.	3 : 3	3 : 3·3	3 : 4·2	3 : 1·9	3 : 3·3	3 : 3·9
Average Body Weight, End of Exp., in lb., oz.	4 : 0·3	3 : 12·7	3 : 13·5	3 : 11·5	3 : 9·6	3 : 9·3
Gain in oz. . . .	13·3	9·4	9·3	9·6	6·3	5·4
Mortality per Pen . .	9	4	9	8	5	9

In every case, due to the increased winter production, the lighted pens gave higher incomes and larger margins over food and lighting costs. The "morning and evening lights" pen (No. 3) gave the best results. The "evening lunch" pen (No. 1) gave a slightly greater margin over food and lighting costs than the "morning lights" pen (No. 2). The "all night lights" pen (No. 5) was the poorest of the lighted pens and gave only slightly better financial gains than the unlighted pens. As compared with the control (no lights) pen (No. 6), the "morning and evening lights" pen gave an increased income per bird of 4s. 10½d., had a higher food cost, 6½d., and an increased margin over food cost of 4s. 4d. The lighting cost per bird was 7¾d. per pullet, so that the increased margin over food and lighting cost per pullet was 3s. 8¼d. for the lighted pen. The "evening lunch" system showed 2s. 3½d., the "morning lights" system 2s. 0¾d., and the "all night lights" 4½d. increased net margin. The increased margin over food and

lighting cost per dozen eggs produced was 1·3, 1·19, ·96, and ·79 pence respectively for these methods of lighting as compared with the control.

Food costs represent from 50 to 60 per cent. of total costs.

Results.—From these results, it would seem that the morning and evening system is the best. In addition to the increased production and income, this system provides absolute regularity from autumn to spring, a reasonable working day, divides the discharge of the batteries between night and morning, which may lighten the load in a home generator and battery. The "evening lunch" system is economical in the use of light, and breaks the time between evening and morning feeds. It is, however, less convenient and less effective than the morning and evening lights, and requires a more expensive regulating device than the morning lights.

The "morning lights" system has been most popular in England, primarily because a cheap switch of home-made construction can be used to bring on the lights. It is neither so convenient nor so stimulating as the morning and evening lights.

The "all night" lights pen gave rather disappointing results in this experiment. An experiment at Ohio Agricultural Experiment Station indicated that the "all night" lights system was superior to the "morning lights" method.

The experiment was continued, and the results of the methods of lighting on hens indicates that to date the "all night" lights method is superior to all others for hens, which is in agreement with the results from the United States. During the first six months of the second year of the experiment (4th August 1931 to 18th January 1932), the "all night" lights pen has laid 2,211 eggs, and given a margin over food cost of £10, 3s., as compared with 871 eggs, and a margin of £1, 8s. 10d. for the control (no lights), 1,392 eggs and £4, 18s. 1d. margin for the 14-hour day, 1,334 eggs and £4, 2s. 9d. for the "evening lunch," and 1,082 eggs and £2, 16s. 4d. for "morning" lights. There are 30 birds in the "all night" lights pen, one having died during the six months.

THE PLACE OF COD-LIVER OIL IN PIG FEEDING.

A. H. BLISSETT, B.Sc.
Rowett Research Institute, Aberdeen

OWING to the diversity of opinion existing as to the value of cod-liver oil in pig production, a series of experiments was conducted at the Duthie Experimental Stock Farm during the years 1930-32, to find out whether any improvement in rate of growth, economy of production, and health could be effected by the feeding of small quantities of cod-liver oil to pigs which were healthy at the start of the experiments, and were fed on a normal, well-balanced ration.

A total of 128 pigs was used in the following experiments, of which 32 received no cod-liver oil, and the remainder cod-liver oil in varying amounts.

The pre-experimental treatment of all the animals was the same. The sows prior to farrowing were kept outdoors in a six-acre field with suitable shelter and natural water supply. After farrowing inside, the sows and young pigs were allowed exercise, whenever the weather permitted, in grass paddocks adjoining the farrowing byre. This outdoor exercising of the young pigs continued until the experiments began, after which the pigs were confined indoors.

The basal ration consisted of :

40 per cent. Sharps,	20 per cent. Ground Maize,
25 per cent. Ground Barley,	15 per cent. Extracted Soya Bean Meal,

Plus 2 lb. separated milk per 1 lb. meal,
Plus 3 lb. per 100 lb. meal of a mineral mixture of :

40 parts Ground Limestone,
40 parts Steamed Bone Flour,
20 parts Salt,
10 parts Ferric Oxide, and
0·04 parts Potassium Iodide.

In Test B no separated milk was given. All these minerals were added to ensure that the result could not possibly be complicated by any deficiency other than the vitamins of cod-liver oil. Some are probably unnecessary. It is, therefore, not to be taken as an ideal mineral mixture for pigs.

Succulent food was supplied daily in the form of swedes during the winter months and cut grass during the summer months.

Four separate tests were done with 32 pigs in each. The 32 pigs were divided into four comparable groups of 8 pigs each, each group being subdivided into two pens of four pigs each. In all the tests the pigs were 75 to 100 days old, and weighed between 45 and 65 lb. at the beginning of the test, which was carried on until the animals were ready for market as bacon pigs, about 200 lb. weight.

The amounts of cod-liver oil fed in addition to the basal diet were as follows :—

Group I. . . .	None.
,, II. . . .	1 c.c. per pig per day.
,, III. . . .	5 ,, ,, ,, ,, ,,
,, IV. . . .	10 ,, ,, ,, ,, ,,

In two of the tests the dams of the litters from which the experimental animals were taken received 20 c.c. of cod-liver oil per head per day while suckling the litters. In the other two the dams received no cod-liver oil. It is known that the vitamins of cod-liver oil may be stored in the body, so that the pre-experi-

mental feeding of the young pigs during the suckling period would affect the results. The young pigs sucking the sows receiving cod-liver oil would get milk richer in vitamins than those sucking sows receiving no cod-liver oil.

Two of the tests were done in winter with autumn-farrowed litters, and two in summer with spring-farrowed litters, so that it might be possible to get more information on the seasonal variations in the requirements for cod-liver oil. Under ordinary conditions one would expect a more marked effect from feeding cod-liver oil in winter than in summer.

The following tables show the gains in weight and the amounts of food consumed per lb. gain.

TABLE I.

Average Daily Live Weight Gains.

	Winter Test. Autumn Farrowed Litters.		*Summer Test. Spring Farrowed Litters.*	
	Test A. 84 Days. Dams received no C.-L.O	*Test B.* 90 Days. Dams fed C.-L.O.	*Test C.* 86 Days. Dams received no C.-L.O.	*Test D.* 99 Days. Dams fed C.-L.O.
Group I. (No C.-L.O.)	1·30	1·12	1·24	1·35
,, II. (1 c.c. C.-L.O.)	1·28	1·17	1·25	1·35
,, III. (5 c.c. C.-L.O.)	1·27	1·17	1·31	1·32
,, IV. (10 c.c. C.-L.O.)	1·34	1·12	1·20	1·31

TABLE II.

Food consumed per lb. Live Weight Increase.

	Test A. lb	*Test B.* lb.	*Test C.* lb.	*Test D.* lb.
Group I. (No C.-L.O.) . .	3·56	3·41	3·72	3·70
,, II. (1 c.c. C.-L.O.) .	3·63	3·28	3·68	3·71
,, III. (5 c.c. C.-L.O.) .	3·66	3·27	3·50	3·78
,, IV. (10 c.c. C.-L.O.) .	3·54	3·37	3·73	3·83

From the results of live-weight gains and food consumption, as shown in Tables I. and II., there would appear to be no value to be attached to the feeding of cod-liver oil in any of the quantities used in our experiments, to healthy pigs, fed on a well-balanced diet. It will be seen that the feeding of cod-liver oil in any of the quantities used in these experiments had no effect upon the rate of gain in weight nor upon the food requirements to fatten the pigs. Clinical examination of the animals throughout the experiments showed no differences between the groups except in the case of 2 of the 8 pigs receiving no cod-liver oil in Test A, *i.e.* pigs fed in winter, and whose mothers had received no cod-liver oil. These showed a certain degree of stiffness in their gait. This continued until they were sold. The condition did not affect the rate of growth, but it may be safe to assume that it was a

sign of rickets, and that probably all the animals in this group may have been on the borderline of developing symptoms of rickets. If this assumption is correct, it would appear that the feeding of the cod-liver oil to the sows when suckling their litters tended to prevent the subsequent development of rickets in the young pigs.

It is important to note that these rather negative results of the effects of feeding cod-liver oil were obtained in the case of pigs which were on an otherwise good ration. In previous experiments which have been done here, it has been found that a much more marked beneficial effect was obtained on a poorer basal diet, especially one deficient in lime.

The results of these experiments, which are in keeping with a number of other tests which have not been published, suggest that while the indiscriminate feeding of cod-liver oil to pigs, provided they are on an otherwise good ration. does not justify the cost, the feeding of cod-liver oil to nursing sows, and also to very young pigs being reared in winter can be recommended as a precaution against rickets.

Conclusions.—1. Even when fed on a well-balanced ration, pigs reared during the winter months are liable to suffer from bone disease, and a small quantity of cod-liver oil (1 teaspoonful per pig daily) will help to correct this.

2. Cod-liver oil has no value for pigs reared in the spring and summer months if they have been well managed by judicious feeding and exposure to sunlight during their early life.

INSECT PESTS.—No. XVI.

R. Stewart MacDougall, M.A., D.Sc., LL.D.

Hitherto in our review of Butterflies and Moths, Beetles, and Flies, we have been dealing with insects more or less familiar, and some of them well known to most people, whether interested in insects or not. But we have now reached an Order of Insects, the *Rhynchota* or *Hemiptera*, a very large Order, containing great numbers of insects that the ordinary observer never notices, and concerning which even the interested observer does not know very much. It is common to see a collection of moths or butterflies, or of beetles, and even of flies, but it is a rare thing to find one interested enough in Rhynchota to collect them. This is due partly to their comparatively unattractive appearance, to the difficulty of the preservation of many of them in a collection, and to their smallness in size. From the economic standpoint, however, this Order contains many of the most serious enemies of farm and garden plants, fruit bushes and trees, and nursery and forest trees.

Popularly speaking, Rhynchota is the Order of Plant Lice and

Bugs. The word bug in America connotes any insect, an insect collector being spoken of as a bug-hunter. With us, when the entomologist speaks of bugs, he usually means not all insects, but only Rhynchota, and especially one of the two main divisions of Rhynchota. Sometimes the word bug is used in a very limited sense to denote one special member of the Order not usually mentioned in polite society, but which later will call for some notice here.

CHARACTERS OF THE ORDER RHYNCHOTA.

Wings four (the male Scale Insects have only two wings, while female Scale Insects and others are wingless). The mouth-parts

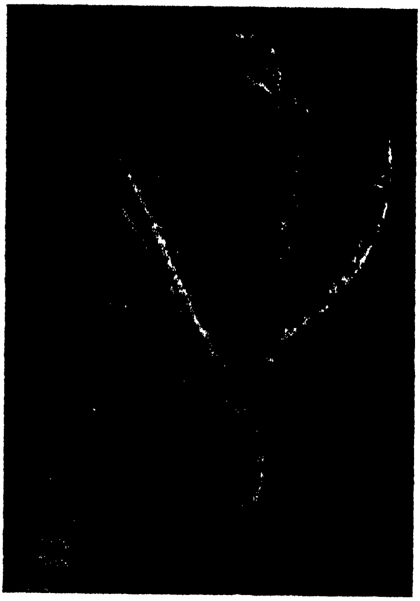


FIG. 1.—Turnip Leaves spoiled by Aphids. From Nature. About ¼ natural size.

are piercing and sucking, being fitted for a liquid diet, generally of plant juices and sap, but sometimes blood. The under-lip (*labium*) is elongated to form a stiff, more or less flexible sheath or gutter, in which lie four piercing bristles, the modified mandibles, and maxillæ ; the mandibles are serrated at their tip. Over the base of the groove or gutter lies the short, somewhat kite-shaped upper lip (*labrum*). The bristle or hair-like mandibles and maxillæ can be sent beyond the tip of the grooved under-lip, and a wound made in leaf or stem, or root, or flower, or fruit, and the sap pumped up into the mouth. Where great numbers of these insects are draining away the sap of the plant, it is easy to understand how infested leaves become distorted, how stems wilt or become galled or swollen, how roots shrivel, and, in mass infestation, why the whole plant dies away. (Figs. 1 and 2.)

The metamorphosis is incomplete, there being no pupal or

resting stage (the males of Scale Insects are an exception). A pupal or resting period is not necessary, because the young hatch from the egg, with external form and food habits more or less resembling those of the parent; they reach the adult condition after feeding and a series of moults. No lying-up stage is necessary, as was the case when we dealt with the difference between maggot and the future fly, grub and beetle, caterpillar and moth; the wing-pads and wings develop as external outgrowths, becoming more prominent at each moult; with the last moult the male or female adult stage has been reached.

A general Classification of the Order will be the easiest and

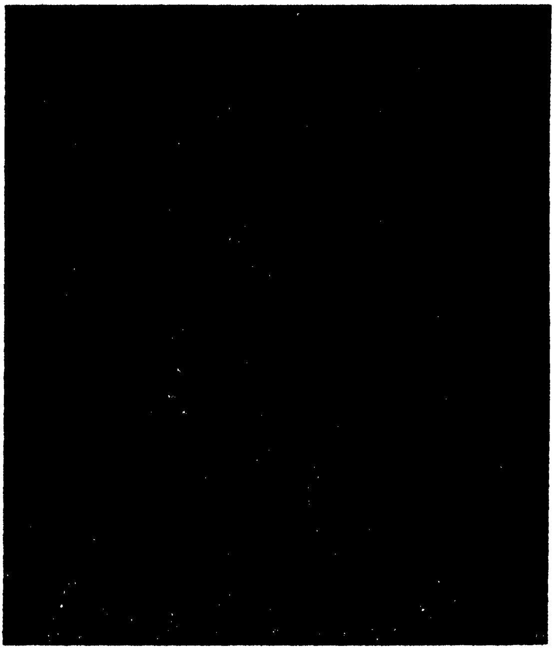


FIG. 2.—Branch of young Silver Fir attacked by Chermes. This plant louse secretes much wax, which serves as a covering. From Nature. Natural size.

most orderly way of giving some idea of the varying forms included in it.

The Order Rhynchota is divided into two Sub-Orders :—

I. **The Homoptera,** in which all four wings (some are wingless) are of the same membranous texture throughout, or if the front wings are firmer than the hind wings, they do not have a hard basal area; when at rest the wings are held sloping over the back. All feed on plant juices.

II. **The Heteroptera,** where the basal part of each front wing is leathery or tough, the apical half being thin and membranous and more or less transparent; hind wings membranous: when not in use the hind wings lie folded on the back beneath the fore-wings. The other name for the Order, viz., *Hemiptera*, meaning half-winged, was given because of this difference in texture

between the basal and apical halves of each front wing. Some of the Heteroptera feed on plant juices, others on the blood of insects or small birds or mammals; some are aquatic, spending their whole life in the water.

THE HOMOPTERA.

Of nine or ten families of this Sub-Order, only four have much economic importance in Britain, the Plant Lice or Aphids; the Jumping Plant Lice (Psyllidæ); the Scale Insects (Coccidæ); the Mealy Wings or "White Flies" (Aleyrodidæ). There are other families with British representatives, but in the tropics and sub-tropics species of these families are far more numerous and destructive. One or two of these call for mention from their biological interest.

The Cicadidæ family, represented in Britain by perhaps one solitary species, contains in it the Seventeen-Year Cicada of America, unfortunately and wrongly called the Seventeen-Year Locust (Locusts belong to quite a different Order). The Seventeen-Year Cicada is an insect 1¼ inch long, dark in colour, with red bands on the abdomen. The female, by means of her ovipositor, cuts slits in twigs and branches for the reception of her eggs, and much damage may result from the many wounds. When the eggs hatch the young drop or pass to the ground, which they enter by cracks and by burrowing. In the soil the insects feed on humus and on the roots of plants, and after sixteen years of feeding and a series of moults the adult stage is reached. For the emergence of the adult the insect comes to the surface, leaves the soil, crawls up a tree, and moults for the last time, then, after its parts have hardened, flies to the tree-tops and finds a mate.

Many will have heard of the Cicada's song. This is a shrill sound that results from the vibration of two drum-like or parchment-like membranes on the under side of the thorax. The Cicada's music is heard only in the daytime, and only the males can "sing," hence the unkind saying, "Happy are the Cicadidæ, for they have voiceless wives!"

Then we have three related families, the Tree Hoppers (Membracidæ), the Leaf Hoppers (Jassidæ), and the Frog Hoppers (Cercopidæ). The Tree Hoppers and the Leaf Hoppers contain species which in warmer countries are destructive to agricultural and fruit plants. The Tree Hoppers are scarcely represented in Britain, and none of the British Leaf Hoppers has marked economic importance, though now and again troublesome on fruit plants.

The Frog Hoppers or Froth or Spittle Insects—*Cercopidæ.*—This family includes some very harmful insects. For example, the Sugar Cane Frog Hopper of Trinidad has worried the sugar planters for years, and much time, effort, and money have been expended in attempts to control it. The adult Sugar Cane Frog Hopper is found on the leaves, and the earlier or nymph stage on

the roots. As a result of the puncturing of leaf and root by the insect's mouth parts and the consequent loss of sap, the root system decays, and a plantation so attacked may come to look as if it had been scorched by fire. The adult is a free, active insect, the nymph, *i.e.* the stage between egg and adult, remains anchored by its beak to root and lower parts of the sugar cane, and surrounded by its bubbles of white froth.

A British species, the Frothing Hopper (*Aphrophora* or *Philænus spumaria*) is the cause of the masses of froth so common in summer on the stems of grasses, of reed plants, and of plants in field and garden. The adult is a four-winged insect, measuring almost ¼-inch in length; yellow-grey in colour, with darker specks; it has a broad rounded head, and long hind-legs fitted for leaping. Although the insect can fly, it seems to prefer leaping, and those who have watched it leaping among bushes, know it as a wonderful jumper for its size. The female lays her eggs in the late part of the season, and the winter is passed in the egg stage. In late spring or early summer the egg hatches into a yellowish, six-legged nymph (the colour varies to green and greenish pink as the nymph grows) that sinks its mouth-parts into the tissue of the stem, and, holding tightly by its legs, proceeds to swallow the pumped-up sap. In time, on feeding, the nymph becomes surrounded by the characteristic froth that has been variously named cuckoo-spit, witches-spittle, frogs-spit, and, by Tennyson, the "froth-fly on the fescue." Some believe that the kind of summer can be foretold from the position the nymph occupies in the froth; if it lies with its head upwards this denotes a dry summer, if the head be downwards the summer will be a wet one. If one puts the froth aside carefully by means, say, of a grass stem, the insect will grip the stem and move along it; this nymph suitably placed, and with mouth-parts sunk again in sappy tissue, may be watched "blowing" its bubbles (the mouth has nothing to do with the bubbles), until the insect is once more completely surrounded by froth.

The froth is a sticky liquid that issues from the hind end of the alimentary canal; it contains a glandular material and has air forced into it. Air is taken when the insect now and again protrudes the tip of the abdomen from the froth; the abdomen tip is then withdrawn into the froth, some air being expelled into and entangled in the sugary overflow from the insect's alimentary canal.

The abdominal segments of the nymph have prolongations on each side, which, under the control of the insect, arch in and form a chamber between them and the under surface of the abdomen; into this chamber the sugary excrement from the hind part of the nymph can pass, and into it the spiracles or breathing pores of the abdomen open. The covering of froth has various uses. The skin of the nymph is delicate, and the froth keeps the insect moist, and prevents shrivelling up in excessive sunshine. The froth also discourages attack of predaceous enemies. One of the

digger-wasps, however, picks out the nymph and carries it away as provision for its carnivorous grub.

Under cover of the froth the nymph feeds and grows and moults, until at length, after its last moult, the winged adult makes its way out and proceeds to its free life in the open. In addition to sexual maturity and the presence of functional wings, the adults differ from the nymphs in their much larger hind legs. The adult Frog Hopper does not surround itself with froth.

THE APHIDS OR PLANT LICE.

Coming now to the families which in Britain are important to the farmer, the gardener, the fruit-grower, and the forester, by far the best known and the most destructive is the family of Aphids, popularly known as Green Flies, though they are not true flies, and many of them are not green.

Plant Lice or Aphids are small, soft-bodied insects with two pairs of delicate wings (wingless forms are common) that have few veins; with six long, slender legs; and with slender antennæ, the various joints of which may, under the microscope, show more or less complex sense organs or sensoria. The mouth-parts are typical of the Order, as described earlier, and as fitted for a liquid diet. On the upper surface of the hind part of the insect one finds a pair of distinct tube-like structures, the so-called honey tubes or cornicles (they may be absent). These honey tubes vary considerably in length and in shape and sculpturing; sometimes their apical opening is just flush with the skin. One should note, despite the name honeytube, that these structures do not give out honeydew, as was once taught, and is often yet stated. They are glandular structures opening from the general cavity of the body, and give exit to a waxy secretion.

Honeydew, once believed by some to come from heaven, and called by Pliny "the sweat of heaven and the saliva of the stars," has a more prosaic origin. It exudes from the food canal of the Aphid, being an excrementitious overflow of the sugary sap pumped up in such quantity from the sugar-making tissue of leaf and shoot, into which the mouth-parts of the Aphid have penetrated. This sugary, sticky exudate is deposited on the leaves of infested plants, and also drops on to plants under those on which Aphids are feeding. It is greedily taken by certain insects, ants especially. To the industrious ant honeydew is a great temptation. Ants visit Aphids for the sake of this honeydew. In some cases the ants protect such Aphids from enemies, and take care of them in severe weather conditions, raising little mud-shelters or "byres" over them or carrying them to their nests. These ants "milk" their Aphid cows regularly for refreshment. The hungry or greedy ant strokes the Aphid with its antennæ, and in response the Aphid exudes from its food canal a droplet of honeydew on which the ant refreshes itself. Ants are known to take the eggs of Aphids to their nests and later, when these eggs have hatched and

external conditions are favourable, the young Aphids are brought into the open by the ants and placed on their proper food plants.

The exudate of honeydew is not confined to Aphids, but occurs also in certain families allied to Aphids. Honeydew can be harmful to plants in two ways. Firstly, the leaf surface gets clogged, and gaseous interchange is interfered with by the blocking of the air-pores or stomata ; further, the sugary liquid forms an excellent

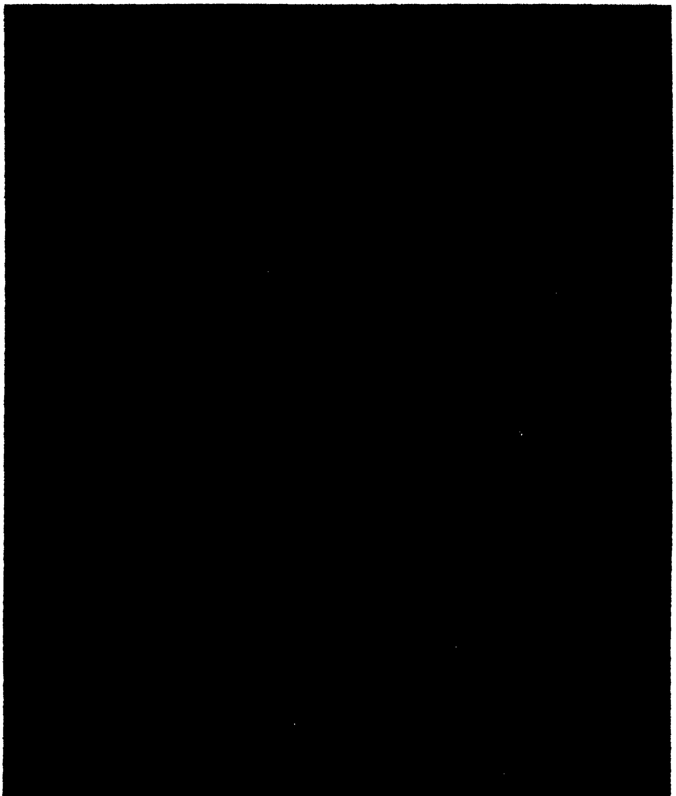


FIG. 3.—Turnip Aphis in moss on under side of a portion of leaf of turnip. From Nature. Magnified.

germinating medium for fungi, some of which may cause disease, even if the fungus be not a parasite. A common result is the covering of the leaf surface with a brown-black fungus, which prevents access of sunlight, and so deprives the plant of feeding area.

The Reproduction of Aphids.—Aphids have extraordinary powers of multiplication, and a feature of their life-history is the habit of giving rise to generation after generation by virgin birth, the new young individuals crawling away from their virgin mothers in actual procession. In the Phylloxeridæ group some of the females lay eggs, which, though unfertilised, duly hatch. In

some Aphid species only females are found, and the reproduction from generation to generation is entirely from these virgin females.

Both groups of the family, the Aphididæ and the Phylloxeridæ, also may at certain times produce sexual individuals, and true pairing takes place, followed by the laying of fertilised eggs. It is the tremendous power of multiplication in conditions that favour the Aphids that makes this group of insects so difficult to control. Individual Aphids are very easy to destroy, but their excessive numbers may render their control next to impossible (Fig. 3).

The Life-Cycle of Aphids.—The life-history is sometimes very complex. Some species pass their complete life-cycle on a host plant of a single species, but with many others a migration takes place to food-plants of quite a different kind. Sometimes this migration to a different species of host-plant is obligatory, there being, later, a remigration to the original species of plant.

Some examples will help to make the possibilities clearer. The Turnip Aphis or the Cabbage Aphis may be taken as an example of a species where the life-cycle is completed on one kind of plant. It will be noted that true sexual males and females come in the late part of the year, the spring and summer generations being composed of females only. Thus :—

Fertilised eggs,
which pass the winter on cultivated and wild crucifers.

↓

These eggs hatch in spring, giving rise to young forms, which develop into

↓

Stem mothers,
which are wingless virgin females that produce live young that develop into

↓

wingless virgin females that produce live young that develop into

↓

wingless virgin females; and so on for a varying number of broods in summer, till, as overcrowding takes place and competition increases, we get

↓

wingless virgin females and winged virgin females; the winged forms fly to other plants where they have more elbow room. Several generations may succeed one another, and then, as

autumn comes on and the weather changes, different forms are developed for the only time in the life cycle, namely :

↓ ↓

winged males and wingless egg-laying females.

Pairing takes place and fertilised eggs are laid, the eggs with which we began this life cycle.

Figs. 1, 2, *and* 3 *by the courtesy of the Highland and Agricultural Society of Scotland.*

COSTS OF PRODUCTION OF WINTER MILK.

ALBERT D. IMPER, B.Sc.(Agr.), M.Sc., Ph.D., N.D.A.

THE cost of production of winter milk has been discussed on many occasions, and with a view to producing some definite figures an investigation into the cost of various factors connected therewith was instituted in December 1931.

After consultation with several farmers, December was selected as a month when normal winter feeding and producing was being carried on. No attempt was being made to increase production in order that the contract quota should be increased, nor was there any indication that any abnormal influence would affect the supply during that month.

Farmers, selected at random throughout the area supplying milk to the City of Aberdeen, were invited to give details of their herds, labour requirements, foods, and production. Except for the necessary overheads, which were arrived at from cost records of dairy farms, all the other information given below was obtained from the returns sent in by the co-operating farmers.

The Herd.—The cows in the various herds were mainly termed Irish or English (shorthorn type), one herd was British Friesian and one Ayrshire, and the bulls, with these two exceptions, were Aberdeen-Angus. In only two instances were the herds maintained by home-bred heifers ; in the other cases either cows or heifers were purchased as required.

Table I. shows the annual replacements of the stock and the number of calves born. This has a very decided influence on the

cost of milk. It will be seen that there are great differences between the farms in this respect. On examination it is found that it is seldom from choice that a farmer replaces his cows to a greater extent than approximately 25 per cent. per annum, but rather from necessity. The main cause is contagious abortion. On several of the farms this has been extremely severe, and it is reasonable to suppose that although the number of herds involved is small, they are fairly indicative of the general situation.

The economic effect of this disease is twofold. In the first place a cow after aborting is usually unable to produce a full supply of milk and, if not disposed of fat, must be maintained dry for a considerable period, and the cost of her maintenance must be debited to the herd. The second loss is the reduction in the number of live calves born, which in a district where there is practically an unlimited demand for black calves, means a loss of about £4 per calf. This forces the milk to pay the full amount of depreciation on the cow, part of which would otherwise be met from the proceeds of the sale of the calf.

TABLE I.

Average Size of Herd.	Range.	Replacements.			Av. Drop on Herd per Month.	Av. Depreciation per Gall. (Dec. Prod.).
		Av. No.	%	Range %		
39·0	21-71	11·6	32·9	19·0-84·0	£7, 5s. 7d.	1·09d.

The treatment of the disease is a matter for the veterinary service. All that need be said here is that any method whereby this great wastage can be stopped or alleviated to any extent would be of great importance to all farmers in the dairy industry.

Foods.—The feeding methods practised are very varied, but in every instance turnips and straw or hay are the basis of the ration. In very few cases is there any attempt to feed exactly in accordance with the individual cow's production, but in two instances each cow has a pail in which its production ration is made up according to gallonage. On the other hand, practically all herds are fed to approximate production. When the foods actually fed are considered in terms of protein equivalent and starch equivalent, it is apparent that in certain cases the ration could be improved with profit to the farmer. On the whole, the tendency is towards heavier feeding than necessary, especially in regard to starch equivalent.

The amount of turnips fed varies from 25 lb. to 122 lb. per head per day, with the majority feeding between 40 and 70 lb. The remainder of the maintenance ration is straw or hay. In one instance silage was used.

The production ration was very varied, but on the whole the farms fall into three groups, according to the method adopted.

These three may be called the concentrated cake or meal feeders, the draff feeders, the combined draff and concentrate feeders.

In a previous survey of the dairy farms in Aberdeenshire it was found that these three groups were present, and at that time the draff feeders predominated. It now appears that a change has taken place, and feeders of concentrates are more numerous. Several reasons for the change have been given by farmers. Many changed because of the difficulty in obtaining draff, while others considered the price too great. Some preferred to use foods which were delivered to the farm, and did not necessitate driving several miles from the station.

The concentrate feeders on the whole are giving a well-balanced ration and are using a variety of feeds in order to obtain this. The choice of these constituent foods is usually based on cost per feed unit or relative cost of other foods where the farmer does not work out the unit costs.

The draff feeders usually have a source of regular supply, and are against changing their methods, or are particularly well situated to the supply and this makes its use an economic proposition.

The intermediate group use the draff as a constituent of a balanced ration, and in most cases the balance is fairly good.

Labour.—The labour requirements are influenced by several factors, some of which cannot be controlled. The chief of these is the convenience of the buildings. In certain cases buildings, although the cow byres are in good order and thoroughly suitable, are not planned in the most convenient way for efficient working. Food stores are sometimes inconveniently placed, manure dumps may be at some distance, and other minor matters may cause time to be lost.

Over the majority of farms for which records were obtained, the cost of labour per cow for the month of December varied very little, and where there was a higher charge than usual this was easily accounted for.

TABLE II.

Labour Requirements in Minutes per Cow and per Gallon (December).

Time expended on cows per head, other than milking time.		Time expended on milking, etc., per cow, per day.		Time expended on milk production, i.e. total per gallon. (December production.)	
Average.	Range.	Average.	Range.	Average.	Range.
15·9	11·0-30·6	20·0	11·8-26·2	19·0	12·3-35·2

The figures given include labour performed by both male and female workers on the basis of time. It is not thought advisable

to use conversion factors in this case, because for milking there is no reason why female labour should be considered less efficient than male labour, as the usually employed conversion factor presumes.

Overheads.—It was thought that a month's record of the overhead expenses would be unsatisfactory, but no composite figure would be complete without some consideration being given to this factor. In order that a fair figure might be adopted, the average of the general overheads as shown by cost accounts of dairy farms was obtained and calculated on the per-head basis. This figure was then interpolated into the monthly record of the farms and the various calculations worked out.

Total Costs.—The following table gives the total cost of production of milk in December as brought out from the records of the co-operating farmers.

TABLE III.

Distribution of the Cost of Production of 1 Gallon of December Milk.

	Average of Farms.	Per Cent.	Range
Foods	6·60 pence	59·5	5·39-9·40 pence
Labour	2·52 ,,	22·7	1·55-4·94 ,,
Depreciation	1·09 ,,	9·8	+·12-3·90 ,,
Overheads	·88 ,,	8·0	·67-1·21 ,,
	11·09 pence	100·0	8·38-15 22 pence

It will be noticed that there is no item for interest on capital investment, and if this is added at the rate of 4 per cent. per annum—surely an amount which cannot be grudged—the figure for the average would be 11·42d. and the range 8·94d.-15·67d. When this is compared with the average wholesale price of 1s. per gallon it will be seen that the dairy farmer, on the average, received ·58d. per gallon for his organising and management.

The figure given above is calculated on the premise that each month of the year should bear its just share of all annual charges, such as depreciation, overheads, and interest. In regard to the latter item, interest has been calculated on the average value of the herd alone, and no charge has been estimated for interest on circulating capital. On all farms a bull or bulls were kept and their upkeep and feed charges have been apportioned to the herd.

Production.—The production of the herd must be considered from two angles, the first the gallonage over the total number of cows in the herd, and the second over the number of cows in milk. It is shown that the return from the milk produced must, if the

enterprise is to be successful, pay all expenses on the herd, so that the first point of view must be the more important.

An examination of the individual records shows that the average of the herd yields was 2·14 gallons per cow per day, and the individual herds averaged from 1·5 to 2·7 gallons. Considering the yields of cows in milk it was found that the average was 2·66 gallons and the range from 2·0 to 3·1 gallons. As the average gallonage per cow in milk varies fairly widely it appears justifiable to assume that the individual cows within any herd will vary greatly also. This brings out the necessity for careful attention to feeding if the most is to be got from the cows and the food is not to be expended wastefully. The prices of the foods show that on the average every pound of starch equivalent costs slightly over 1d., and every pound protein equivalent approximately 6d., so that excess of feeding over a prolonged period is bound to entail a financial loss to the farmer.

Conclusions.—The records show that on the average the cost of production of milk in December can be kept below the wholesale price, but that many farmers will find this impossible for various reasons, some of which are largely outwith their control, while others are possible of adjustment.

The records show that the main factor influencing the cost of milk is production. Where the gallonage was low it invariably followed that the cost per gallon was high. High average production over the year would appear to be the aim of all the farmers, but this can be obtained only if cows can be relied upon to calve at the correct time. Several of the farmers who served their cows with a view to winter calving suffered a severe set-back through early abortion and through cows going dry earlier than would normally be expected. In some herds where abortion was prevalent great difficulty was experienced in getting many of the cows to settle. This held back calving and reduced the milk yield during certain months. More attention should be given to balanced feeds fed in direct proportion to the individual production. The records do not give any indication that one feed is more economic than another provided the balance is good.

Displays and Advertising of Scottish National Mark and other Products.

IN furtherance of their effort to stimulate public interest in the merits of Scottish produce, the Department have continued to exhibit Scottish National Mark and other agricultural produce at some of the principal exhibitions and Empire Marketing Board shops in Scotland and England. This year a considerable degree of success has again attended the Department's efforts, by means of which the introduction of Scottish goods to new territory in England has been effected. Commercial inquiries regarding the commodities displayed are invited, producers and distributors in Scotland being thus afforded a convenient medium for the expansion of business.

Particulars of the exhibitions at which the Department have occupied a Scottish stand, and of other steps taken to secure publicity for National Mark produce, are given below.

British Industries Fair, London, 22nd February to 3rd March 1932.—At this Fair the Department staged an exhibit which included Scottish National Mark malt and canned fruit, together with black and white puddings, cheese, haggis, oat products, oatcakes, Ayrshire roll bacon, and seed potatoes. Samples of all produce, excepting cheese, bacon, and potatoes, were offered for sale, and during the period over 7000 samples were disposed of, an increase of almost 100 per cent. on the previous year's Fair. The display attracted a considerable amount of interest, and a large number of inquiries from home and overseas, of a type likely to lead to definite business, was received and dealt with.

Nation's Foods Exhibition, London, 21st May to 4th June 1932. —Produce of a similar nature to that exhibited at the British Industries Fair was displayed, and samples offered for sale at this Exhibition. The demand for samples of Scottish produce was highly satisfactory.

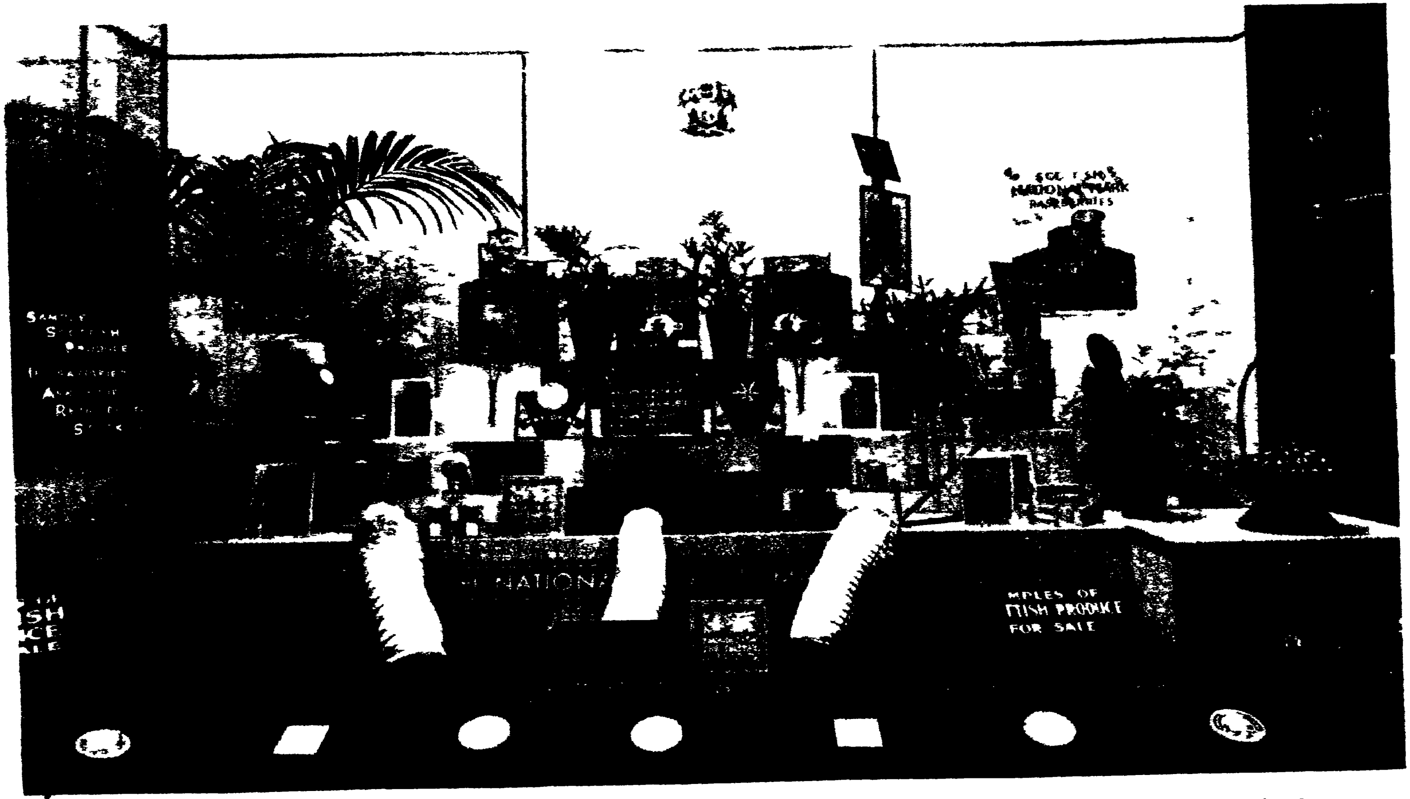
Tinned cream, manufactured in the south-west of Scotland, was shown for the first time by the Department, and attracted considerable attention.

Highland and Agricultural Society's Show, Inverness, 21st to 24th June 1932.—In addition to staging an exhibit of Scottish National Mark tomatoes and eggs at the Highland Show, the Department arranged for a demonstration of (1) the grading of eggs by means of an up-to-date electrically-driven grader, and (2) the testing of eggs for freshness and quality. Examples of common faults in eggs were prominently displayed.

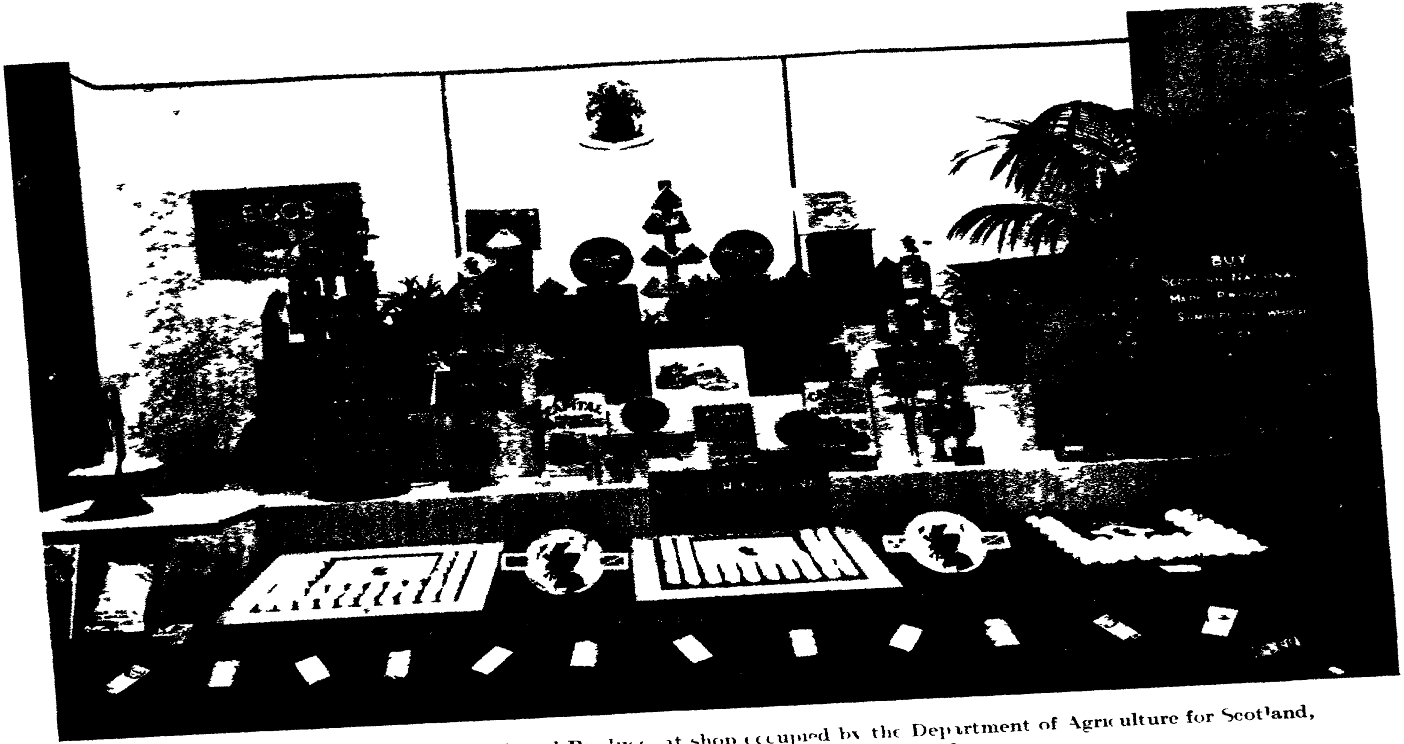
The Department also arranged a competition, confined to registered packers of Scottish National Mark tomatoes, for which 66 entries were received. Prize-money, amounting to £16, was awarded, the judge commenting very favourably on the high standard of the produce entered. The competition aroused much interest, and as a result inquiries regarding the Department's marketing schemes were numerous.

Empire Marketing Board Shop, 10-12 High Street, Sheffield, 27th June to 9th July 1932.—In conjunction with the Fishery Board for Scotland, the Department staged in the above shop a representative display of Scottish produce, comprising Scottish National Mark eggs, tomatoes, malt, and canned fruit, in addition to oatcakes, oat products, Ayrshire roll bacon, haggis, white puddings, cheese, honey, tinned cream, tinned fish, and kippers.

So far as the sale of samples was concerned, the Department's exhibit proved the most successful yet staged by them at an Empire Marketing Board shop. A total of 27,635 small samples of all the commodities displayed was sold during the period, the drawings amounting to more than £380.



Window Display of Scottish Agricultural Produce at shop occupied by the Department of Agriculture for Scotland at Sheffield, from 26th June to 9th July 1932



Window Display of Scottish Agricultural Produce at shop occupied by the Department of Agriculture for Scotland, at Sheffield from 26th June to 9th July 1932

The following is a comparison with previous tenancies of Empire Marketing Board shops by the Department :—

Birmingham .	Samples sold, 14,275	Receipts, £174	15	7
Blackpool . .	„ „ 20,531	„ 306	16	0
Liverpool . .	„ „ 6,677	„ 97	13	10
Sheffield . .	„ „ 27,635	„ 380	18	5

Traders showed great interest, and the exhibit was successful in bringing to their notice several varieties of Scottish produce previously unstocked in Sheffield. Connections were definitely established for Ayrshire roll bacon, Scottish National Mark tomatoes, Scottish cheddar cheese, heather honey, and tinned fish.

Publicity for Scottish National Mark Produce.—The Department have available for distribution, free of charge to packers, wholesalers, and retailers of Scottish National Mark produce, attractive posters, transparencies, and show-cards descriptive of the merits of Scottish National Mark tomatoes, eggs, and canned fruit. For the past year the transparencies have been exhibited on the windows of omnibuses in Glasgow and the south-west of Scotland, while the Empire Marketing Board poster-frames throughout Scotland have been leased by the Department on several occasions during the last two years for the purpose of advertising Scottish National Mark eggs and tomatoes.

Auchincruive.

Notes from Agricultural Colleges.

Pasteurised Milk for Calves.—Recently there has been a demand for information regarding the relative nutritive values of raw and pasteurised milk for the feeding of calves. As a consequence, investigation of the problem has been started by the West of Scotland Agricultural College.

A review of the literature shows that this subject has received relatively little attention from investigators in the past. The results available from the few trials conducted have sometimes been interpreted as indicating that heat-treated milk was equal to, or even better than, raw milk in nutritive value to calves. The term "heat-treated milk" is used here in preference to "pasteurised milk," as there have been great variations in the methods of treating the milk.

If all the trials conducted be considered in the light of modern knowledge, it is found that in the great majority of cases they were not suited to the problem being investigated. Even when this is kept in mind, however, the bulk of the evidence from these earlier trials is in favour of raw milk.

A preliminary feeding trial has been conducted by the College. The aim was to carry two groups of six calves each from birth to 90 days of age. One group received raw milk throughout,

while the other was given raw colostrum for the first five days, and then pasteurised milk.

It was decided that the milk to be pasteurised should be held at 145° F. for 30 minutes.

The calves were fed milk according to their live weight and capacity, and from three weeks of age they received hay and a grain mixture. The latter consisted of equal parts by weight of whole maize, whole oats, nutted linseed cake, and bran.

All of the calves on raw milk finished the trial, though one was rather unthrifty throughout. Of those on pasteurised milk, two died before they were 30 days of age—one as the result of septic pneumonia, and the other from a navel infection which spread until it involved the liver. A third calf was removed from the trial as it reacted to the intradermal test for tuberculosis. This was probably a congenital case.

As a consequence of these losses only five calves out of eight on pasteurised milk finished the trial, while one of those completing the trial died at 92 days of age. This calf was subject to recurrent attacks of scours, and, no matter what treatment was tried, it could not be kept right for more than a few days at a time.

Live Weight Gains.—There are several ways in which the live weight gains can be compared, and they all give similar results. Perhaps the fairest method is to give the percentage increase in live weight. This was calculated for all calves which finished the trial, and, as with all other methods of comparison tried, it came out in favour of raw milk.

The weights for the calf fed pasteurised milk, and which died at 92 days of age, were discarded, and the figures for the least thrifty calf in the raw milk group were also discarded. The average percentage increases in live weight for the remaining animals were as follows :—

	On Raw Milk. Per cent.	On Pasteurised Milk. Per cent.
From birth to 30 days of age .	25	26
,, 60 ,, .	76	76
,, 90 ,, .	154	141

These results are interesting. During the first 60 days the percentage increase in live weight was the same for the two groups, and, if the trial had been finished at that point, it would probably have been concluded that pasteurisation had no influence on the feeding value of the milk. During the last 30 days of the trial, however, there was a distinctly lower rate of gain for the calves on pasteurised milk as compared with those on raw milk.

For the trial as a whole, the raw milk proved to be of greater nutritive value than the pasteurised milk. The amounts of milk, hay, and grain required to put on 1 lb. live weight increase were

greater in the case of the calves fed pasteurised milk than with those on raw milk.

The calves on raw milk all lived, but there was a heavy death-rate in those on pasteurised milk. It is known that there are protective substances in milk, particularly in colostrum, which aid in giving the calf some immunity against disease. From the results of this trial, it appears probable that, in some cases at least, the calf requires longer than is generally believed to acquire its full complement of immunising bodies from the milk of its dam, and that these protective substances may be partially or wholly destroyed by pasteurisation.

It would also appear that the deficiencies of pasteurised milk for nutritional purposes do not necessarily appear rapidly. Some considerable time is necessary before the advantages of raw milk over pasteurised milk are apparent.

From a review of the literature, and the results of this preliminary trial, it appears that pasteurised milk is less valuable than raw milk for calf-feeding. It is hoped to continue this work with larger groups of calves and over a longer period of time.

Craibstone.

Grasses and Clovers, 1932.—After a mild winter, red clovers from foreign countries usually do comparatively better than they do after a more severe winter. This, to some extent, was the case in trials carried out this year. Several samples from each country were included, and the following are some of the chief results.

	Grass. cwt.	Clover. cwt.	Total. cwt.
BROAD-LEAVED—			
French	30·9	11·1	42·0
Chilian	34·9	10·8	45·7
English	28·0	23·7	51·7
Gloria	30·8	7·4	38·2
Italian	29·3	10·4	39·7
LATE-FLOWERING—			
American Mammoth	31·9	16·3	48·2
English	25·8	31·7	57·5
Montgomery	26·7	37·0	63·7
Polish	32·4	8·1	40·5
Russian	34·1	3·4	37·5
Swedish	28·5	26·2	54·7
,, (Poor)	34·9	4·1	39·0

Chilian, although not nearly so good as English, was better than it has been for some years, and it was interesting that one sample was better than the other three samples from that country. French was much the same as in previous trials, but one sample was also better than other four tried.

Italian, which was brought prominently to notice last year by the National Farmers' Union, was also poor.

Three samples (out of 40) of the English Broad-leaved gave poor results—very similar to Chilian and French. The history of one of the samples was traced, and it was found that the English farmer had sown foreign seed, and it is likely that the other two samples were of similar origin.

It is learned that in at least one district in England the question of forming Seed Growers' Associations, as in the case of Montgomeryshire L. F., is under consideration. This would be of considerable advantage to farmers in the North of Scotland, as they would be sure that English seed is true English and not once-grown foreign.

Among the foreign samples was one called Gloria. There was a much larger proportion of dark-coloured seeds in this sample than in any sample ever sown in these trials. Seedsmen lay great stress on the colour of the seed, and this sample was considered perfection. It is interesting to note that it did very poorly.

It looked at one time as if the Late-flowering type was to be poorer than Broad-leaved, but the former improved considerably during June. There were several samples of American Mammoth, but all gave poorer results than English, while Polish and Russian were almost entire failures.

In former trials Swedish Late-flowering generally did extremely well. This year four samples were included but only one was good, the other three being extremely poor and very similar to the Russian. In all probability these samples were really Russian, but had reached this country *via* Sweden.

Twenty different samples of Montgomery were tried, and although several showed a small proportion of Broad-leaved, all samples produced very vigorous plants. Two out of twenty English samples were Broad-leaved, the others being mainly true Late-flowering and vigorous.

A plot with Alsike did very poorly.

In second year's pasture at the beginning of the season, Montgomery and Swedish were about equal, but as the season advanced the former was distinctly better. Even in third year's pasture there was a fair quantity of Montgomery present.

Samples of wild white clovers from different counties of England and New Zealand were sown in 1930. The following table shows the relative vigour of the different samples this year:

	Very Good.	Good.	Fair.	Poor.
American	–	–	–	1
Bedford	–	–	1	–
Buckingham . . .	–	1	–	–
Cheshire	–	1	–	–
Cotswold	–	1	–	1
English	–	–	1	4
Essex	–	1	2	1
Gloucester	–	–	1	1

	Very Good.	Good.	Fair.	Poor.
Hampshire	–	1	–	–
Hereford	–	1	2	2
Kent	7	25	9	–
Lincoln	–	1	–	–
New Zealand	–	–	7	16
Norfolk	–	–	1	1
Northampton	1	5	1	–
Oxford	–	–	1	–
Suffolk	1	3	1	–
Wilts	–	1	2	1

These results indicate that while some samples from other counties were quite good, the Kent, Northampton, and Suffolk samples were distinctly superior, while even the best of New Zealand samples lacked vigour.

The plants from a sample of ordinary white had almost disappeared, as also had those from a sample of mixed Alsike and white.

In a field of second year's grass there was a number of plots seeded with the same seed mixture, except that the kind and quantity of white clovers varied. The white clovers included were :

(*a*) English Wild White.
(*b*) Ordinary White.
(*c*) American White.
(*d*) New Zealand White, which gave a strong chemical reaction.
(*e*) New Zealand White, which gave a weak chemical reaction.

Each of these was sown at the rates of ¼, ½, 1, 2, and 4 lb. per acre.

In (*b*), (*c*), and (*e*) there was very little white clover in any of the plots. In fact, there was quite as much in a plot where no white clover had been sown; (*d*) was slightly better, and there was most clover where the most seed had been sown; (*a*) was outstanding, even the plot where ¼ lb. had been sown being better than the best plot in (*d*). The ½ lb. and 1 lb. were thicker, and the latter was quite as thick as the plots seeded with 2 and 4 lb. These plots were first eaten by the cattle.

In a field of fourth year's grass is a plot where 1 lb. of ordinary white had been included in the mixture. During the last two years this plot has filled up with natural white, as also has a plot where no white at all had been sown. These plots were eaten quite bare at the beginning of the season along with the rest of the field, but later on they were neglected, whereas the grass alongside where wild white had been included in the mixture was eaten bare. The reason possibly is that the natural white flowers and seeds earlier than wild white, and hence was not so succulent at this particular time.

Among samples sent in by farmers for examination were two said to be wild white. These were tested for purity and

germination and a chemical test made. The results were as follows, a good sample being included for comparison:

	Price per lb.	P.	G.	Chemical reaction.	Real effective quality.	Value per lb.
1. Good Sample .	7/–	99	95	V. strong	94	7/–
2. Low Germination .	6/–	97	65	Strong	54	4/–
3. Weak Chemical Reaction .	3/6	98	90	Weak	25	1/9

There is often some controversy regarding the advisability of grazing new grass during winter or spring. In November, a plot of one-tenth acre was fenced off and it was grazed with six sheep for three days. This equals 180 sheep per acre for one day. Another similar area was grazed in May, the rest of the field being ungrazed. The hay was cut in July, and the weights obtained were as follows:

	Per acre:— Grass. cwt.	Clover. cwt.	Total. cwt.
Grazed by Sheep in November .	22·0	17·2	39·2
,, ,, May . .	21·0	15·1	36·0
Ungrazed	20·8	26·4	47·2

The poorer yield of hay from the grazed plots is due to a reduction of red clover.

It is just a question whether the grazing obtained compensates for the reduced hay crop. It may also be noted, however, that the white clover appears to be coming in quicker on the grazed portions.

There was a considerable amount of Pluff grass or Yorkshire Fog (*Holcus*) in many pastures this year. In a field of fourth year's grass a portion was fenced off in April for an experiment for another purpose. It was decidedly undergrazed, with the result that it became very rough and a considerable amount of Pluff went into ear. The other part was well and carefully grazed in June and July and then rested for a time. At the beginning of August there was a nice thick sole with little appearance of Pluff, and what there was was fresh and succulent so that it was eaten quite readily when the field was subsequently grazed. Representative samples of each of these parts were taken and separated out with the following result:

	Under-grazed. Per cent. (by weight).	Well grazed. Per cent. (by weight).
Clovers	34	53
Pluff Grass and Weeds .	45	9
Grasses	21	38

A good many farmers are now following the excellent practice of cutting their pastures in June and July when they become rough.

It should be noted that the flowering of Pluff grass extends

over a considerable time, there being early, medium, and late flowering ears. For this reason, it would be well not to cut rough pastures containing this grass too early, otherwise the late flowering ears would subsequently come into bloom. When the majority are in bloom the plant is at its weakest, and when cut at this stage, there is not the same danger of its coming into ear again during the season.

The trials with Early-flowering or stalky and Late-flowering or leafy grasses, chiefly perennial ryegrass and cocksfoot, are being continued. In the first trials with individual plants the latter type was decidedly superior, each plant producing about double the amount got from the former. This looked promising, and high hopes were entertained that there would be a big advance in pasture production.

When sown in mixtures the stalks of the late-flowering, perennial ryegrass were distinctly later in hay than where Ayrshire was used, while the late-flowering cocksfoot showed comparatively few stalks, but there was a much larger proportion of leaf blades than in the case of Danish. There has been little difference, however, in the total weight of hay obtained per acre. In the aftermath, the Danish cocksfoot grew quickest and was first eaten by cattle.

In pasture, the Danish again came away first in spring and was eaten with avidity; later, however, the leafy came away and was much thicker and was well eaten, whereas the Danish went more readily into ear and did not stock out to the same extent. It was noticeable, however, that although there were fewer blades of cocksfoot there was much more timothy. Representative samples were taken from parts that had been well eaten and came up again fresh so that there were no ears. These, when separated out, gave the following results (by weight):

	From Danish Cocksfoot Plot. Per cent.	From Leafy Cocksfoot Plot. Per cent.
Perennial Ryegrass	11	11
Cocksfoot	8	17
Timothy	17	10
White Clover	56	54
Weeds	8	8

The leafy perennial ryegrass was also preferred and was well eaten down, whereas the Ayrshire often went into ear.

Grazing trials in progress with fourth year's grass, however, indicate so far that the mixtures containing these two types of perennial ryegrass and cocksfoot do not show much difference in live weight increase.

Review.

An Introduction to the Scientific Study of the Soil. Norman M. Comber, D.Sc., Professor of Agricultural Chemistry in the University of Leeds. Second Edition, 1932, pp. 208. Edward Arnold & Co. 7*s.* 6*d.*—The first edition of Professor Comber's *Introduction to the Scientific Study of the Soil* appeared in 1927, and at once gained recognition from teachers of agricultural chemistry as an admirable text-book for the ordinary degree and diploma student. The experience gained by its use during the past five years has amply confirmed the very favourable impression which it aroused on publication. It was the first text-book to give in concise form an introduction to the modern views and conceptions of soil investigation, and provided an admirable introduction to the study of the subject. It is gratifying, therefore, that a new edition should be called for so soon.

The second edition follows the same general lines as its predecessor; the chief additions are an enlargement of the section (Chapter III.) dealing with soil microbiology, and the rewriting of the section dealing with the mechanical analysis of soils. It is doubtful if the new section on soil microbiology adds anything to the value of the book; the treatment is necessarily slight, and it probably would have been better to have left the microbiology of the soil, which is now a well-defined branch of the subject, to the soil bacteriologist.

The treatment of Soil Nitrogen (Chapter XI.) is not very satisfactory, particularly the section dealing with nitrification; the argument is involved, and the presentation undoubtedly obscure, some of the statements being in actual conflict with each other.

Interesting chapters follow on the classification of soils and on the artificial treatment of soils, leading up to a useful discussion of the various methods of studying experimental treatment in the field.

In Chapter XV. a guide to the literature of the subject is given, and a useful bibliography of British and American work on soil investigation.

The work, as a whole, is written in a clear and attractive style. It can be most cordially recommended as a useful text-book to all teachers of agricultural chemistry, while it should have a wider appeal to agriculturists, horticulturists, and botanists.

It is certain that the new edition will be as useful and as successful as its predecessor.

Fertilisers and Feeding Stuffs Regulations, 1932.

NEW Regulations have been made to replace the Fertilisers and Feeding Stuffs Regulations, 1928. The new Regulations came into operation on the 1st September 1932, and are known as the Fertilisers and Feeding Stuffs Regulations, 1932 (S.R. & O., 1932, No. 658). Copies may be obtained through any bookseller, or directly

from H.M. Stationery Office, 120 George Street, Edinburgh, price 10d., exclusive of postage.

The chief changes in the Regulations relate to the methods of sampling and analysis, and alterations to the Schedules to the Fertilisers and Feeding Stuffs Act, 1926. In addition, doubts as to the limits of variation for nitrogen and potash in compound fertilisers have been removed.

With regard to sampling, the Regulations have been amended mainly in order to facilitate the work of the officials concerned. The methods of analysis have been amended by the substitution of the British Standard Test Sieve, Mesh No. 100, for the present prescribed sieve for determinating the fineness of grinding of basic slag, etc., and also by the inclusion of a method of analysis for the determination of citric soluble phosphoric acid.

Alterations to Schedules are confined to the First, Second, and Fourth Schedules to the Act. It may be explained that the First and Second of the Schedules to the Act include the classes of articles in respect of which the seller is required under the Act to give to the purchaser a statutory statement, which has effect as a warranty containing certain prescribed particulars. In the Fourth Schedule to the Act, the names of the more commonly used fertilisers and feeding stuffs are defined, and the use in a statutory statement of any of these names constitutes a warranty that the article accords with the relative definition.

The amendments to these Schedules relate to feeding stuffs, with the exception of " Lime mixtures," which is now one of the fertilisers appearing in the Second Schedule.

To the Second Schedule has been added Alfalfa Meal, which is now defined in the Fourth Schedule as " Alfalfa (Lucerne) as grown, dried and ground, to which no other matter has been added."

For the term " Barley Meal " (First and Fourth Schedules) has been substituted "Barley Meal" and " Barley Meal, Grade II.," which are defined for the purpose of the Fourth Schedule, as follows :—

" Barley Meal—The meal obtained by grinding barley, as grown, which shall be the whole grain together with only such other substances as may reasonably be expected to have become associated with the grain in the field ; the meal to contain not less than 96 per cent. pure barley."

" Barley Meal—Grade II.—The meal, other than barley meal as defined above, obtained by grinding barley, as grown, which shall be the whole grain together with only such other substances as may reasonably be expected to have become associated with the grain in the field ; the meal to contain not less than 90 per cent. pure barley."

Bean Meal and Pea Meal are now described (Fourth Schedule) as follows :—

" Bean Meal—The meal obtained by grinding commercially pure beans of the species (1) Vicia Faba (synonym Faba vulgaris)

or any of its varieties, commonly known as 'horse bean,' 'field bean' or 'broad bean'; or (2) Phaseolus vulgaris, the 'true haricot bean' or any of its varieties, white or coloured."

"Pea Meal—The meal obtained by grinding commercially pure peas, as grown, of varieties of Pisum sativum or Pisum arvense."

New definitions are given in the Fourth Schedule of Feeding Meat and Bone Meal, and of Feeding Meat Meal, as follows :—

"Feeding meat and bone meal—'The product, containing not less than 40 per cent. of albuminoids (protein) and not more than 4 per cent. of salt, obtained by drying and grinding animal carcases or portions thereof (excluding hoof and horn) and bone, to which no other matter has been added.'"

"Feeding meat meal—'The product, containing not less than 55 per cent. of albuminoids (protein) and not more than 4 per cent. of salt, obtained by drying and grinding animal carcases or portions thereof (excluding hoof and horn) to which no other matter has been added.'"

Guide to Current Official Statistics, Vol. X.

EACH year sees the publication of a wide range of Government surveys, returns, and reports on all kinds of subjects of international, national, or local importance. Hundreds of these contain statistics which are constantly needed by persons engaged in the study of some question on which authoritative information is essential. In the absence of a systematic index to this vast store of statistical material, the individual inquirer would find it very difficult to discover which official publications contained precisely the information he required.

The necessary clue is provided by the annual *Guide to Current Official Statistics*, which contains not only a list of the titles and prices of the statistical volumes issued by each Government Department, but also an alphabetical index of their contents, with particulars of the degree of detail in which the subject is treated and the time and place to which the statistics relate.

By following the directions given for using the Guide, the inquirer is enabled to ascertain in a few minutes exactly what official statistics relating to his subject are available, and the names and prices of the publications in which they are located.

Volume X. of the Guide (price 1s. net, post free 1s. 5d., pp. 357) has been issued, and may be obtained direct from the sale offices of H.M. Stationery Office, or through any bookseller.

Agricultural Research Council Scholarships.

Owing to the financial emergency, it was not possible to make the normal provision for the award of new Agricultural Research Scholarships in the academic year 1932-33. In these circumstances the Agricultural Research Council decided that, in order to keep the Scholarship Scheme in being, they would award, out of the funds at their disposal, not more than two Studentships for Research in Animal Health, and not more than three Agricultural Research Scholarships.

Awards on this basis have been made for the academic year 1932-33, and the administrative arrangements are being undertaken on behalf of the Council by the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland.

Nature of Vitamins.

In an article in this *Journal*, Vol. XV., No. 2, p. 159, it is stated that "three Swedish investigators have recently announced the discovery of a, or the chemical precursor of vitamin C..."

The Department have now been informed by Professor H. Isaachsen, Institute of Animal Nutrition, Royal Agricultural College, Norway, that these investigators are Norwegians, viz., O. Rygh, Mrs Aagot Rygh, both bachelors of science in chemistry, and P. Laland, bachelor of science in pharmacy. Some details of their discovery will be found in *Avhand-linger utgit av Det norske Videnskabsakademi i Oslo*—papers published by the Norwegian Academy of Science and Arts in Oslo (1932, p. 3).

Agricultural Returns, 1932.

The Preliminary Statement of the Agricultural Returns taken in Scotland on 4th June 1932 shows that the total area under crops and grass amounts to 4,624,000 acres, comprising 3,049,000 acres of arable land and 1,575,000 acres under permanent grass. The total acreage is the smallest recorded since 1876, while the area of arable land is the smallest recorded since the Returns were first taken in 1866, being less than in 1931 by 3,000 acres. The area under permanent grass has decreased this year by 5,000 acres, making the total diminution in the area under crops and grass 8,000 acres.

The area under rotation grasses and clover, 1,513,000 acres, has decreased by 21,000 acres, while the "tillage" area, *i.e.* that under grain, green crops, etc., is 17,700 acres larger than in 1931.

There have been reductions in the areas of barley, turnips and swedes, rape and vetches, tares, etc., for fodder amounting to 33,400 acres, and of beans, sugar beet, and mangolds amounting to 800 acres. Increases in the areas of wheat, oats, and potatoes

amount to 51,500 acres, and of rye, cabbages, peas, and small fruit to 400 acres.

The outstanding features of the crop returns are the large increases in oats and potatoes, and the further large decreases in barley and turnips and swedes. Wheat shows an increase of 2,500 acres over 1931, but is 1,500 acres below the 1930 figure. Barley and turnips and swedes, with decreases of 18,000 acres and 11,300 acres respectively, continue the diminution of the acreage under these crops in recent years, and show new low records. Oats, with an increase of 31,000 acres over 1931, also show an increase of 4,000 acres over 1930, but are 23,000 acres less than in 1929. The potato acreage of 146,000 is the highest since 1922, with the exception of 1927, in which year 147,000 acres were returned. The small fruit area shows a very slight increase for strawberries, an increase of over 100 acres for raspberries, and decreases of about 50 acres for gooseberries and 20 acres for other kinds of small fruit. There is an increase in the area under carrots of about 120 acres, and slight increases in the other crops not separately specified in the accompanying table, except for lucerne and flax, which show reductions.

Of the area under permanent grass, 168,000 acres were cut for hay and 1,407,000 acres were grazed, while of the area under rotation grasses and clover, 400,000 acres were cut for hay and 1,113,000 acres were grazed. The area under permanent grass for mowing was greater than in 1931 by 2,500 acres, and under rotation grass for mowing was less than in 1931 by 22,000 acres: the total area cut for hay is thus decreased by 19,500 acres.

The live-stock returns show that horses have decreased in numbers, while cattle, sheep, and pigs have increased.

Horses used for agricultural purposes are fewer than in 1931 by 1,400, the total, 115,800, being the smallest on record. Unbroken horses of one year and above are fewer by 100, or 0·7 per cent., while foals show no change on last year's figures. The decrease in horses of all kinds is 2,500, or 1·6 per cent.

The total number of cattle, 1,221,800, is greater than last year's figure by 13,000, or 1·1 per cent. With the exception of two-year-old feeding cattle, which are down by 3,500, all classes of cattle show increases—calves 5,900, yearlings 4,100, heifers in calf 2,800, or 5 per cent., cows in calf but not in milk 500, cows in milk 3,000, and bulls used for service 200, or 1·1 per cent.

The total number of sheep, 7,846,600, shows an increase of 15,800, or 0·2 per cent., as compared with that of 1931. Ewes, which number 3,421,300, exceed last year's record number by 6,300, or 0·2 per cent., while lambs have increased by 27,500 to 3,366,600, which is the largest number on record. Rams show an increase of 1,300, while other sheep, one year and above, show a decrease of 19,300, or 2 per cent.

Pigs, which total 163,200, show an increase of 1,000, or 0·6 per cent., on last year's figure. Sows, however, have decreased

by 700, or 3·4 per cent., while boars and other pigs have increased by 100 and 1,600 respectively.

The returns of labour employed (excluding occupiers of holdings, their wives and domestic servants) at 4th June 1932 are given below together with the figures for 1931. Regular workers are fewer by 600, while casual workers show an increase of 100.

The returns of poultry at 4th June 1932 are also given below, together with the figures for 1931.

	1932.	*1931.*
Regular Workers.		
(*a*) Males, 21 years old and over ..	58,900	59,200
(*b*) Males under 21 years old ..	20,000	20,200
(*c*) Women and Girls	18,000	18,100
Casual Workers.		
(*a*) Males, 21 years old and over ..	5,500	5,400
(*b*) Males under 21 years old ..	2,800	2,800
(*c*) Women and Girls	6,800	6,800
Total	112,000	112,500

	1932.	*1931.*
Fowls over six month old	3,360,000	3,129,600
Fowls under six months old ..	3,990,000	3,948,500
Ducks over ,, ,, ,, ...	158,000	145,100
Ducks under ,, ,, ,, ...	84,000	85,200
Geese over ,, ,, ,, ...	7,400	8,200
Geese under ,, ,, ,, ...	13,500	14,300
Turkeys over ,, ,, ,, ...	16,000	23,900
Turkeys under six months old ..	65,000	69,100

There is given below a Preliminary Statement, compiled from the returns of varieties of potatoes grown in 1932, of the acreage as at 4th June under the principal varieties, together with the figures for 1931. The acreage accounted for here is 128,700, the remaining 17,300 acres not being included in the returns of varieties. The finally revised figures will be published as usual in October.

First Earlies.

	1932.	*1931.*
Duke of York	1,500	1,540
Eclipse	1,400	1,250
Epicure	8,700	7,220
Sharpe's Express	1,900	1,610
Others	1,000	910
Totals ..	14,500	12,530

Second Earlies.

	1932.	1931.
Ally	350	250
Arran Comrade	300	280
Great Scot	9,100	7,810
British Queen	3,850	3,780
Royal Kidney	450	370
Others	1,150	830
Totals ..	15,200	13,320

Maincrops.

	1932.	1931.
Arran Banner	1,100	770
Arran Consul	800	660
Golden Wonder	9,500	9,370
Kerr's Pink	59,000	45,760
Majestic	8,500	6,730
Arran Chief	2,200	2,300
King Edward VII.	12,400	14,990
Others	5,500	4,810
Totals ..	99,000	85,390

CROPS AND GRASS.

Distribution.	1932.	1931.	Increase.		Decrease.	
	Acres.	Acres.	Acres.	Per Cent.	Acres.	Per Cent.
Total Area (excluding Water)	19,069,007	19,069,007	..	..	..	..
Total Acreage under all Crops and Grass (a)	4,624,000	4,632,000	..	..	8,000	0·2
Arable Land	3,049,000	3,052,000	..	..	3,000	0·1
Permanent Grass (a) For Hay	168,000	165,500	2,500	1·5	..	..
Permanent Grass (a) Not for Hay	1,407,000	1,414,500	..	..	7,500	0·5
Total ..	1,575,000	1,580,000	..	..	5,000	0·3
Wheat	52,500	50,000	2,500	5·0	..	..
Barley (including Bere)	70,000	88 000	..	..	18,000	20·5
Oats	866,000	835,000	31,000	3·7	..	..
Mixed Grain	2,000	2,000	..	..	..	..
Rye	3,250	3,200	50	1·6	..	..
Beans (to be harvested as Corn)	2,800	3,300	..	..	500	15·2
Peas	550	400	150	37·5	..	..
Potatoes	146,000	128,000	18,000	14·1	..	..
Turnips and Swedes	350,000	361,300	..	..	11,300	3·1
Mangolds	1,150	1,200	..	..	50	4·2
Sugar Beet	750	1,000	..	..	250	25·0
Cabbage	4,600	4,500	100	2·2	..	..
Rape	8,200	10,800	..	..	2,600	24·1
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	8,900	10,400	..	..	1,500	14·4
Small Fruit	8,300	8,200	100	1·2	..	..
Rye-grass and other Rotation Grasses and Clover. For Hay	400,000	422,000	..	..	22,000	5·2
Rye-grass and other Rotation Grasses and Clover. Not for Hay ..	1,113,000	1,112,000	1,000	0·1	..	..
Total ..	1,513,000	1,534,000	..	..	21,000	1·4
Other Crops	4,000	4,000	..	..	..	..
Bare Fallow	7,000	6,700	300	4·5	..	..

(a) Excluding Mountain and Heath Land used for grazing.

LIVE STOCK.

	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural Purposes (including Mares for Breeding)	**115,800**	117,200	..	..	1,400	1·2
Unbroken Horses (including Stallions) { One year and above	**14,400**	14,500	..	..	100	0·7
Unbroken Horses (including Stallions) { Under one year ..	**4,800**	4,800	..	..	..	..
TOTAL ..	**135,000**	136,500	..	..	1,500	1·1
Other Horses	**15,200**	16,200	..	..	1,000	6·2
TOTAL OF HORSES ..	**150,200**	152,700	..	..	2,500	1·6
Cows in Milk	**349,200**	346,200	3,000	0·9	..	..
Cows in Calf, but not in Milk	**52,200**	51,700	500	1·0	..	..
Heifers in Calf	**59,000**	56,200	2,800	5·0	..	..
Bulls being used for Service	**18,000**	17,800	200	1·1	..	..
Other Cattle :—Two years and above	**190,500**	194,000	..	..	3,500	1·8
,, ,, One year and under two ..	**297,400**	293,300	4,100	1·4	..	..
,, ,, Under one year	**255,500**	249,600	5,900	2·4	..	..
TOTAL OF CATTLE ..	**1,221,800**	1,208,800	13,000	1·1	..	..
Ewes kept for Breeding	**3,421,300**	3,415,000	6,300	0·2	..	..
Rams to be used for Service	**95,800**	94,500	1,300	1·4	..	..
Other sheep :—One year and above	**962,900**	982,200	..	..	19,300	2·0
,, ,, Under one year	**3,366,600**	3,339,100	27,500	0·8	..	..
TOTAL OF SHEEP ..	**7,846,600**	7,830,800	15,800	0·2	..	..
Sows kept for Breeding	**19,700**	20,400	..	..	700	3·4
Boars being used for Service	**2,200**	2,100	100	4·8	..	..
Other Pigs	**141,300**	139,700	1,600	1·1	..	..
TOTAL OF PIGS ..	**163,200**	162,200	1,000	0·6	..	..

Agricultural Conditions.

THROUGHOUT the whole country the weather during June was remarkably fine and dry. Mild and sunny conditions prevailed everywhere, and the rise in temperature gave a great stimulus to the growth of crops, while the fine, genial weather had an excellent effect upon all classes of live stock. Towards the end of the month, however, when the soil was becoming excessively dry and hard, and the lack of moisture was affecting the growth of pastures, rain fell in all districts. Unsettled conditions prevailed during July, and at times the weather was by no means favourable for the progress of seasonal work on farms, but, taken on the whole, crops and live stock made very fair progress. The humid conditions had a most beneficial effect upon pastures, potatoes, and root crops, but considerably retarded the hay harvest. During the last few days of the month thunderstorms, with intermittent heavy rain, beat down small portions of the grain crops. Throughout August the weather was dry, warm, and bright in practically all parts of the country. The grain ripened quickly and harvest proceeded under exceptionally favourable conditions. Pastures and root crops benefited by showers of rain that fell at the end of the month.

Wheat was in ear at the beginning of July. The crop stood up well and ripened very satisfactorily. The straw was of good length, and the ears were heavy and well filled. During the last

ten days of August harvest became general in the principal districts where the crop is grown. The estimated yield was in most districts from 5 to 10 per cent. above the average, while in South-west Perth it was thought that it would exceed the average by from 15 to 20 per cent.

The growth of barley and bere was satisfactory, although not quite so favourable as in the case of wheat. Towards the end of June growth was checked by the continued dry weather, and for a time some of the plants lost colour and suffered from the lack of rain, but the wetter conditions of July had a most pronounced and beneficial effect upon the general appearance of the crop. In most of the eastern counties rather a large proportion of the crop was lodged, but the damage was not very serious. In early districts, where the work of ingathering began during the third week of August, a small part of the grain was safely in the stack-yard before the end of the month. The crop bulked well in the stook and appeared to be well matured. In a few northern districts at the end of August it was anticipated that the yield would be slightly below the normal, but in most districts an average yield was expected, while in several rather widely scattered areas it was estimated that the crop would be 5 per cent., and in some cases 10 per cent. above the average.

Oats developed into a healthy and satisfactory crop generally. On light soils the dry weather in June caused the straw to be rather stunted, but the heads filled out well and the grain ripened rapidly. In some fields the crop was lodged, but not to any considerable extent. On low ground at the beginning of September cutting had made good progress, and in the early districts of the south part of the crop had then been stacked. The work was generally carried out in good order. The grain appeared to be of good quality, and the estimates of the yield were quite satisfactory. Most of the estimates were at least up to the average, while nine reporters estimated a yield 5 per cent., eight 10 per cent., and five 15 per cent. above the average.

Beans benefited from the warm and rather humid weather that occurred during July. The straw was rather short in some districts, but the plants podded well and suffered little or no damage from insect pests or disease. At the end of August the crop was ripening satisfactorily and on some early farms harvest was just about to begin. In Stirling, Clackmannan, and Fife the prospects were very good, and it was anticipated that the produce would be 5 or even 10 per cent. above the average, while in most of the other districts the yield was expected to exceed the average by fully 5 per cent.

The weather conditions suited potatoes admirably, and above the ground, at all events, the crop grew exceptionally well. At the beginning of August the haulms had a fresh and flourishing appearance and were almost entirely free from disease, but towards the end of that month the plants were touched by occasional night frosts, while in some western and south-western

counties susceptible varieties were slightly affected by blight. At the beginning of September in several eastern districts the prospects for main crops were reported to be exceptionally favourable. In three districts the estimates of the yield exceeded the average by 20 per cent., while in four other districts they exceeded the normal by 15 per cent., in eighteen by 10 per cent., and in eight by 5 per cent. Eight reporters anticipated an average yield, while two estimated that the crop would be deficient by about 5 per cent. as compared with the average of the last ten years.

The sowing of turnips and swedes was late in completion, and at first growth was unusually slow. At the beginning of July a small proportion of the crop had not yet brairded, while in many districts, as a consequence of the dry condition of the soil, the prospects of the crop were very uncertain. The mild, moist weather of July favoured the plants, and where the seed was not sown too late they made a rapid recovery. The plants rooted well, and at the end of August they generally had a strong and healthy appearance, but they were not bulbing satisfactorily, and in some fields the crop was then decidedly backward in growth. Very few complaints of finger-and-toe were received, but the reports revealed that in several areas the crop was affected with mildew. In most districts there were prospects of an average yield, and in several western and south-western counties it was thought that the yield would be from 5 to 10 per cent. above the normal, but in some parts of the eastern counties it was expected that the crop would be below the average by from 5 to 10 per cent. Mangolds seemed to make better progress than turnips. They grew slowly at first but responded to the sunny and warm conditions of August. The rain that fell at the end of that month benefited the roots and, judging by their appearance generally, it was then thought that the crop would probably prove to be somewhat above the average.

As a consequence of blight the yield of strawberries in South-east Lanark was about 15 per cent. below the average, while in South-east Perth a large part of the crop was spoilt by rain. Elsewhere the yield of strawberries generally proved to be a fair average. The weather was favourable for the gathering of raspberries and the crop was harvested in good order. In South-east Perth the yield of raspberries was the heaviest on record, and the price paid for the fruit ensured a full picking. Hard fruits were much less satisfactory. At the beginning of September plums had proved rather a disappointing crop, and pears were reported to be indifferent. Apples were fairly good in some districts, but elsewhere the fruit was less plentiful than usual.

Along the eastern sea-board and in some of the southern counties pastures remained fresh and abundant throughout June, and in some areas the herbage was of excellent quality, but in the north and west the dry weather of that month caused grazings to become rather bare. The warmth and moisture of the latter part of July, however, caused a strong growth of grass of good

feeding value, and, despite the low rainfall during August, pastures generally continued fairly fresh and green until the beginning of September. Grazing cattle were rather short of grass in some districts during June, but during July they improved in condition quickly, and thereafter they throve well. Dairy cows maintained their condition in a satisfactory manner. Sheep on arable farms made very good progress, and lambs put on flesh and were marketed in good bloom. Hill sheep flocks prospered, and reports on their condition were satisfactory in every way.

Stocks of bees were strong and healthy, and there was no mention of disease anywhere. In practically all districts the yield of clover and flower honey was above the average, especially in the early part of the season. Heather blossomed rather early this season, and in consequence of the bright, sunny weather during August the prospects of heather honey were exceptionally good.

The supply of regular and casual workers was generally sufficient for requirements, and in several districts a number of competent men were unemployed. In the south Irish labourers were engaged for harvest, but in some districts they found more difficulty than usual in securing employment.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Black-leg on Cabbage and Swedes. *Olaf Nielsen, Tids. f. Planteavl,* 38 *B.* 1 *H.*, 1932. (From the writer's English Summary).—Black-leg is caused by the fungus *Phoma lingam.* It spreads through the seed, and has been isolated nine times from Danish cauliflower and sugar-loaf cabbage seed as well as from cauliflower and sugar-loaf cabbage plants. Cabbage seed was found to contain from 1 to 30 infected seeds per 1,000.

The seed is infected in the siliques. The fungus is found as dormant mycelium in the rudimentary seed albumen between the seed shell and the germ. The germ itself is first infected during germination. Many seedlings die with symptoms of "damping off."

Dry-rot is ascribed to the fungus *Phoma napobrassicae.* It has been proved that this disease is spread with the seed in the same way as "black-leg." The fungus has been isolated four times and found many times on seeds of swedes.

Black-leg and dry-rot resemble each other in the main. Investigations reported here show that the two fungi *Phoma lingam* and *Phoma napobrassicae* are identical. *Ph. oleracea, Ph. napobrassicae* and *Ph. siliquastrum,* and *Aposphaeria brassicae* are synonyms for the same fungus, *Ph. lingam.*

Of the preventive measures against this disease only two are at present valuable —seed disinfection and a suitable crop rotation to control soil infection.

Control of Finger-and-Toe: Experiments with Lime and Fertilisers. *J. C. Gibb, New Zealand Journal of Agriculture, January* 1932, *Volume* 44, *No.* 1.—From experiments conducted at the Plant Research Station, Palmerston North, New Zealand, it appeared that lime did not always present the development of finger-and-

toe. Apparently time must be allowed for the lime to penetrate to the deeper layers of the soil in which the roots grow. When penetration was incomplete, infections frequently occurred at more or less uniform depth, some inches below the surface of the soil. This type of infection was fairly common in soil limed two or three months before sowing the crop, while in unlimed areas practically all the plants were attacked at the level of the soil surface.

The experiments showed that lime must be applied at least three months before sowing the seed. Time must be allowed for the lime to permeate the soil in which the roots will grow. When sowings took place too soon after liming, finger-and-toe was frequently observed at depths of 2½ inches, 3 inches, or 4 inches below the soil surface.

In the experiments under review effective control was obtained by dressings of two to three tons of burnt lime applied three months before seeding. Similar control was obtained by applications of three to five tons of carbonate of lime applied at a smaller period before seeding. When lime was applied twelve months in advance of sowing, satisfactory finger-and-toe control was obtained with a dressing of one to two tons per acre of burnt or freshly air-slaked lime.

Lime did not kill the spores of the organism, but rendered the soil environment unsuitable for their germination. The sowing of an acid fertiliser in contact with the seed may, temporarily at any rate, neutralise the effect of the lime and make the soil conditions about the seed suitable for the disease to develop.

Freezing Experiments with Cultivated Plants. *H. N. Frandsen, Nordisk Jordbrugsforskning*, 1931.—The following is taken from the writer's English summary. The objects of the experiments were :—

(1) On the basis of freezing experiments to obtain information as to the relative hardiness of various varieties and strains of cultivated plants.

(2) By means of artificial hardening, in connection with freezing experiments and analyses, to obtain information as to the best way of hardening the plants.

The experiments showed the following results :—

Freezing experiments with different wheat varieties showed great variation in the respective hardiness. The differences found correspond exactly with experience on hardiness of the different varieties made under field conditions.

Freezing experiments with common rye-grass show, too, that various strains of rye-grass differ greatly in hardiness. Victoria rye-grass from Svalof and the Danish rye-grass strain E.-F. 79 are very hardy. Øtofte rye-grass shows medium hardiness, and Lundbaek rye-grass is but slightly hardy.

Experiments with rye-grass show also that resistant types may be selected in artificial freezing experiments.

Hardening experiments with wheat, rye-grass, and swedes have shown that plants can be hardened artificially, and that hardening is most apparent in hardy plant varieties.

The changes of greatest importance for increasing the hardiness of plants are reduction of water content and increase of sugar content. In both cases the cell juice becomes more concentrated, the amount of pure water, *i.e.* water not associated with the cell colloids, is decreased, and the freezing-point correspondingly lowered.

Several of the experiments have shown plainly that the roots are much more sensitive to frost than the parts of the plants above the ground.

DAIRYING.

Colour of Milk as affecting its Marketability. 1932. *Paper read to the American Dairy Science Association. H. A. Ruehe and H. K. Wilson.*—In different parts of the world consumers have different standards for the colour of the milk. In some parts it is essential that, to meet the consumers' desires, the milk should be of a slightly yellow colour. In certain districts milk distributors and consumers have been concerned over the fact that the proportion of bottled milk below the cream level often appears to have a pale blue colour.

Dr Ruehe and Dr Wilson state that certain breeds of cattle produce milk with an intense yellow colour, and also that green feed is an important factor in producing the yellow pigment in the milk. Their paper deals principally with the colour of the milk below the cream level and the effect of plant processes upon this colour. They found the dominant hue of skim milk, 0·03 per cent. fat, to be blue green. There was also a great variation of the different colour of lots of skim milk having the same fat content. With an increase in the fat content the dominant hue changed towards a yellow colour. Besides the food and the individuality of the animal, its health also seemed to influence the colour of the milk.

The Fat Percentage of Milk as affected by Feeding Milk to Dairy Cows. *Nat. N. Allen.* 1932. *Jour. Dairy Science, Volume* 15, *No.* 2, *pp.* 132-141.—It is a general

belief that by nutritional methods it is not possible to alter the butter fat content of the milk. In this experiment Mr Allen dealt with Holstein-Friesian cows in the herd of the University of Minnesota. Three of these, each producing about 40 lb. of milk daily, were fed whole milk with a fat-content of about 4 per cent. in amounts up to 36 lb. per day. Since none of the cows would drink liquid milk it was necessary to add milk to the dry grain ration. Some of the cows refused to eat the feed which was moistened with milk until a small amount of molasses was added to overcome the milk flavour. Thus of the three cows, the one which consumed the milk most readily suddenly refused to take the milk after it had been fed for nearly two weeks. Another of the three was removed from the herd because of disease, and the third was fed 30 lb. of her own milk daily during alternate intervals, and samples were tested from each milking. On the basis of observations made during these preliminary trials, an experiment was planned using eleven cows of three breeds—Jersey, Holstein, and Guernsey—and in various stages of lactation. The milk was fed by mixing it with the grain ration in the proportion of 2 lb. of milk for 1 lb. of grain. During control periods a normal amount of water was substituted for the milk. Following a six-day preliminary period, the cows were divided into two groups; one was fed the regular ration moistened with whole milk and molasses, while the other was fed the regular ration moistened with water and molasses.

The writers conclude that when whole milk was fed during alternate six-day periods it was followed by a marked increase in butter-fat percentage, and greater butter-fat production resulted. This effect first became apparent about twenty-four hours after the milk was added, and was maintained for an equal length of time after it was discontinued. Similar results were obtained by feeding cream of high fat content. The increased butter-fat production secured by feeding whole milk or cream may be maintained for at least twelve days. Skim-milk feeding did not bring about an increase in either butter-fat production or butter-fat percentage. There were considerable individual variations in the manner in which response was made to the effect of milk. No unfavourable physiological effect was observed in cows fed up to 40 lb. of milk containing over 2 lb. of butter-fat daily, even when added to the ration in the full amount after a period in which no milk was fed.

ANIMAL BREEDING.

The Influence of Sex on the Quality and Palatability of Beef. *M. D. Helser, P. Mabel Nelson, Belle Lowe, B. H. Thomas, and J. W. Woodrow.* 1932. *Iowa Agr. Exp. Sta. Leaflet No.* 29.—This is the continuation of a series of experiments on the palatability of beef of which the authors have already published their results concerning the effect of age. In this investigation they found little difference between the steer and heifer carcases in the percentage of fat and bone at the start or at the end of 90 days of feeding. As the feeding period progressed, however, and the animals became fatter the difference was wider. The percentage of lean to fat became less in both steers and heifers, but the difference increases faster in the case of the latter.

As regards the quality of meat produced as judged by the prime rib, there appeared to be little difference between heifers and steers. Similarly there was an improvement in the quality of roasts from both steers and heifers as the period progressed.

The variation in the amount and distribution of elastic tissue appeared to be due to individual animals rather than to difference in sex. For the purpose of this experiment animals of both sexes were slaughtered at the start and at different times during the feeding period. These results relate only to what would be termed "baby beef," animals slaughtered at about 7 cwt. live weight.

The Development of the Mammary Gland. *Paper read to the American Dairy Science Association. C. W. Turner, A. H. Frank, and A. B. Schultze* (*a*).—Dr Turner and his associates are continuing their important work into the factors affecting milk secretion. In the present study they report that the stimulus for the growth of the gland comes from an estro-genic hormone, secreted by the ovary, which they call "theelin." They found that long-continued injections of this hormone into spayed animals did not carry the development of the gland beyond a certain point, but that the initiation of pregnancy for the first time caused rapid growth of the glands, especially as regards the lobules along the sides of the ducts corresponding to the leaves of a tree. They state that it is in the alveoli of the lobules that the secretion of the milk occurs.

The growth of the gland lobules is completed about the middle of pregnancy. The stimulus of this growth comes also from structures in the ovary. A hormone extracted from the corpora lutea of the ovary, called "corporin," when injected with the estrogenic hormone, theelin, stimulated lobule growth in experimental animals. Thus it may be said that the full growth of mammary glands of male and female ovariectomised mammals has been produced experimentally. The authors have thus

proved that the two hormones of the ovary are responsible for the normal growth of the gland.

The Development of the Mammary Gland. *Paper read to the American Dairy Science Association.* 1932. *C. W. Turner and W. U. Gardner.* (*b*) *Initiation of Secretion.*—With the completion of the growth of the mammary gland at the middle of pregnancy, the changes in the gland leading to the initiation of milk secretion at parturition take place. Because of the rapid enlargement of the udder during the second half of pregancy, the idea has become common that the greatest growth of the gland takes place during the latter part of pregnancy. This, the authors state, is not correct. The growth is completed during early pregnancy while the initiation of secretory activity causes the enlargement of the gland during the latter part of pregnancy. Stricker and Gruter in 1929 reported that the hormone responsible for the initiation of lactation was to be found in the anterior lobe of the pituitary, a small structure at the base of the brain. Dr Turner and his associates have made an intensive study of the action of this hormone. They have given it the name of "galactin." They were able to obtain galactin from the extraction of sheep pituitaries. The extracts were found to be without effect on the undeveloped mammary glands of immature animals. They took effect only when the udder had been properly developed as described in their previous paper. They were able to induce lactation in castrated male rabbits into which the duct system was developed, first by the injection of theelin and then by theelin plus corporin for the necessary lobule growth, and then finally with galactin. Thus by the proper sequence in the administration of the hormones the growth of the mammary gland and the initiation of milk secretion corresponding to that observed at the end of pregnancy have been observed.

The Influence of Age of Cows and Age of Bulls on the Number of Services required for Conception. 1932. *Paper read to the American Dairy Science Association. R. F. Morgan and H. P. Davis.*—There is a belief that the young sire is more certain to cause conception with fewer services than an older sire. The writers working on the records of the University of Nebraska herd studied the factors of the age in relation to the number of services as regards breed and time of year. For cows under two years of age 24 per cent. more services were required for conception than for cows of three years of age, and 6 per cent. more services were required for two-year-old cows compared with three-year-old cows, when bulls of all ages were used. There was little difference in the services required for conception in the ages from 4 to 10 years, the average being slightly above that for three years. The belief that age has any effect on sex ratio is disproved, the writers finding males to be consistently higher in ratio than the females.

Yearling bulls showed the smallest number of services for conception, requiring 11 per cent. fewer services than the two-year-old bull, and 15 per cent. fewer than the three-year-old bull. There was little difference amongst the bulls whose ages ranged from 4 to 8 years. Altogether, the yearling bull bred to yearling heifers gave the fewest services for conception, while bulls three years and older when bred to yearling heifers showed more services for conception than the same bulls on older cows. This would indicate that young bulls are decidedly more effective on young heifers.

A Study of the Gestation Period of Holstein-Friesian Cows. *J. C. Knott.* 1932. *Jour. Dairy Science, Volume* 15, *No.* 2, *pp.* 87-97.—The data used in this study were obtained from three pedigree Holstein-Friesian herds in the State of Washington. The figures are based on 2910 gestation periods. 78 of the animals included were Grade Holsteins; 86 cases of twins were born and were considered separately in the presentation of the data. The length was found to vary from 262 to 296 days. 75 per cent. of the calves were dropped from 275-285 days inclusive. Only 1·7 per cent. were carried for periods shorter than 270, and 2·7 per cent. for periods longer than 290 days. Male calves were carried on an average one day longer than female calves. As the age of the dams increases from two to six years, the length of the gestation period increases by approximately 1 to 1½ days. After six years there seemed to be a tendency for the gestation periods to become slightly shorter.

The gestation periods of calves sired by some bulls were definitely higher or lower than the average, indicating by their uniform divergence from the mean the possibility of paternal influence. The least variation in the length of gestation observed for 29 cows that had each produced six or more calves was six days. The greatest was twenty days. Some cows were quite uniform as to the length of their gestation periods, while others varied widely. Eleven exceptionally high-producing cows were carried in dam an average of 278 days, or about one and one-half days less than the average for all females. The periods varied from 262 to 289 days. In comparing the gestation periods of the above cows with the gestation periods of the calves they produced, it was found that four of the eleven cases showed a decided tendency for the calves of a cow to have gestation periods similar in length to her own.

ANIMAL NUTRITION.

Cattle.

Effect of Ultra-violet Light on Milk Yield of Cows. *Kroon, H. M. Milchwirtsch. Zbl.*, 1931, 60, 237, 253, 269-273. (*Zootech. Inst., Univ., Utrecht.*)—Irradiation of the udder of healthy, milking heifers with a small sunlight (Hanau, 600 candle-power) lamp had no effect on milk yield. Japanese workers have, however, reported increase of milk yield due to irradiation, and therefore further experiments were made in which a 2000 quartz lamp was used to irradiate, not only the udders, but the whole body of several animals and their food. These also gave negative results, and it is concluded that the Japanese results must have been due to deficiency of some factor (vitamin ?) influencing milk secretion.

Feeding Value of Maize and Sunflower Silage and their Effect on Yield and Fat Content of Cow's Milk. *K. Richter, K. E. Ferber, and H. Koppisch. Landwirtsch. Jahrb.*, 1931, 74, 521-533. (*Nutrition Res. Inst., Prussian Inst. Res. in Animal Breeding.*)—The observations included metabolism experiments on wethers and a feeding experiment on the period system with milch cows. The metabolism experiments, on account of considerably lower digestibility of all constituents in the sunflower silage, gave a starch equivalent of only 22·7 kg. per 100 kg. dry substance, with 2·27 per cent. digestible crude protein, as compared with 41·3 kg. starch equivalent with 5·97 per cent. crude protein in maize silage. The milk production experiment showed that sunflower silage can be used on the basis of its digestible nutrients, and that, if cows are gradually accustomed to it, up to 30 kg. per head per day may be given.

Effect of Feeding Palm Kernel Cake on Fat Content of Milk. *C. Kronacher, J. Kliesch, and E. Leberl. Deutsch. landwirtsch. Tierzucht*, 1932, 36, 221-223. (*Inst. Animal Breeding, Agric. Coll., Berlin.*)—It had previously been shown that the feeding of not less than 2 kg. palm kernel cake per head per day raised the fat content of milk by 0·34 per cent. In the present experiment of 7 cows, from 2·1 to 3·9 kg. palm kernel cake per day was added to the other concentrates in proportion to milk yield. All animals showed an increase in fat content of milk, varying from 0·2 to 0·7 per cent., with an average of 0·4 per cent. The amount of the increase was not determined by the level of feeding palm kernel cake, but by the individuality of the animal, provided that the minimum quantity (about 2 kg.) was fed. Milk yield was not affected.

Fattening Young Bullocks. *G. Frölich and H. Lüthge. Kühn-Arch.*, 1931, 31, 69-92. (*Inst. Animal Breeding and Dairying, Univ., Halle a. S.*)—On the basis of experiments with a ration of potatoes, fodder beet, dried slices, ensiled potatoes, lucerne hay and, as protein supplement, soya bean meal and earthnut cake, the following feeding standards are suggested :—

WEIGHT OF BULLOCKS AND DAILY FEED REQUIREMENT.

kilograms.	Digestible Protein. grams.	Starch Equivalent. grams.
150	400	1400
200	500-550	2000
250	700-750	3400
300	750-850	3800
400-500	900-1000	4400-4800

The daily amount of concentrates fed should not exceed 2 kg.

Supplementary Feeding of Carbohydrates to Suckling Calves with Reference to the Utilisation of Milk Protein. *N. Remer. Biedermanns Zentralbl., B. Tierernahrung*, 1932, 3, 463-506. (*Agric. Chem. and Bacteriol. Inst., Friedrich Wilhelms Univ., Breslau.*)—An extensive review of the literature on the nutrition of the young animal, and on milk substitutes in the rearing of calves is given. In the experiments reported dried potatoes supplemented by distillery malt were fed from the first week and gradually increased to 400 g. per head per day without any detrimental effects, and thereby replacing 2 litres of whole milk. The potato-fed calves excreted more sulphur in the fæces than did the milk-fed calves. This difference is attributed to alkaline putrefactive processes in the large intestine of the milk calves which are supposed to liberate sulphur in a form in which it can be absorbed and eliminated in the urine. The ratio of N to S retained in both groups was practically the same, viz., 16 : 1. The author calculates that by using potatoes the cost per lb. of live-weight gain is reduced by about 16 per cent.

Importance of Preparatory Feeding before Lambing for Milk Yield of Ewes and Development of Lambs. *R. Kellner. Dissert. Breslau*, 1931. (*Exp. Stat., Animal Breeding and Dairy Farming, Univ., Breslau.*)—Observations were made on 30 ewes in three groups. A considerable increase in milk yield was found in the ewes given preparatory feeding, and this increase would probably have been more marked if feeding conditions had not been unusually good. The yield of ewes with twin lambs, both as regards milk and growth of lambs, was considerably higher than that of ewes with single lambs.

Fodder Beet compared with Silage for Fattening Weaned Lambs. *K. Richter, K. E. Ferber, and K. W. Hundt. Deutsch. Schäfereiztg.*, 1931, 23, 55. (*Res. Inst. Animal Nutrit., Pruss. Inst. Animal Breeding, Tschechnitz.*)—The experiment was made on two groups each of 6 animals, for 61 days. At slaughter quality of flesh and fat was excellent in both groups, and losses were within normal limits, so that neither beet nor silage has any unfavourable influence on quality of product. The silage groups made a higher average increase, 187 g. per head per day as compared with 147 g. in the beet group.

Pigs.

Use and Value of Barley Meal, Rye Meal, and Molassed Rye Meal in Pig Fattening. *F. Honcamp. Biedermanns Zentralbl., B. Tierernährung*, 1932, 4, 1-42. (*Rostock.*) —A summary report on co-operative experiments carried out on behalf of the German Association of Agricultural Experiment Stations at eight centres, with a total of 228 pigs. The average fattening period was 90 days. The general conclusions are quite favourable to the use of rye, provided that the average amount given over the fattening period does not exceed 2 kg. per head per day. With heavier rates of feeding the results are not equal to those given by barley, partly because of the greater difficulty of securing full consumption. Greatly improved results were obtained when 10 per cent. of molasses was mixed with the rye meal. For farm practice it is recommended that in meal feeding rye should not form more than one-half of the total, whilst where potatoes are being fed the supplement of rye meal should not exceed an average of about 1 kg. over the whole fattening period. If it is desired to feed rye meal more liberally it should be mixed with 10 per cent. of raw sugar or molasses.

Comparative Experiments with Meat Meal, Herring Meal, and Cod Meal on Pigs. *G. Lunde, K. Scharrer, and W. Schropp. Arch. f. Tierernahrung u. Tierzucht*, 1931, 7, 21-278. (*Res. Inst., Norwegian Preserving Ind., Stavangar, and Agric. Chem. Inst., Weihenslephan, Tech. Coll., Munich.*)—Three similar groups of pigs on the same basal ration received equal supplements of protein in the concentrates investigated. The condition of the animals showed no difference. Daily weight increases in the meat-meal groups were 562 g., in the fish-meal group, 582 g., and in the cod-meal group, 629 g. Concentrate consumption per kg. increase was similar in all groups. Iodine excretion was higher in the cod-meal group than in the other groups on account of the higher intake.

Utilisation of Dried Sugar Beets in Practical Pig Fattening. *G. Frölich and H. Lüthge. Ztschr. f. Schweinezucht*, 1932, *39*, 57-58. (*Inst. Animal Breeding and Dairying, Univ., Halle a. S.*)—Dried sugar beet in quantities commencing with 100 g. and rising to 1 kg. per day were fed along with a mixture of fish meal, soya meal, barley, and rye, the amount of cereals being reduced as the sugar beet was increased. The mixture was rationed, and the remaining appetite of the pigs satisfied with steamed potatoes and mangolds in the average proportion of 2 : 1.

The test was not comparative but permitted of the general conclusion that dried sugar beet could be used safely and with good results up to 1 kg. per day under the conditions indicated.

Poultry.

Can the Chick balance its Ration? *E. M. Funk. Poultry Science*, 1932, 11, 94-97. (*Univ. Missouri, Columbia.*)—Day-old white Leghorn chicks were fed for eight weeks on a free choice diet of nine ingredients. The amount of each ingredient consumed was determined every week. The chicks selected a uniform ration during the whole period, suggesting that the physiological demands are constant throughout the period. Normal growth was obtained during the eight weeks involved. The average percentage of each foodstuff consumed was corn meal, 39·4 per cent.; wheat bran, 11·1 per cent.; wheat shorts, 29·3 per cent.; dried buttermilk, 6·1 per cent.; dried skim milk, 4·8 per cent.; meat scrap, 4·8 per cent.; alfalfa leaf meal, 0·9 per cent.; bone meal, 3·0 per cent., and salt 0·2 per cent.

Protein Requirements of Chickens. *J. S. Carver. J. L. St John, T. E. Aspinall, and I. H. Flor. Poultry Sci.*, 1932, 11, 45-57. (*State Coll. Washington, Agric. Exp. Stat., Pullman, Washington.*)—Three groups of White Leghorn chickens were kept on wire floors for 38 weeks from hatching, during which time growth figures and nitrogen balances (week periods) were kept. Dried skim milk was added to a cereal mixture, to give rations with 12·1 per cent., 15·4 per cent., and 18·2 per cent. of protein. Best growth for the first few weeks was given by the high protein ration, and worst by the low protein ration. The low protein level retarded sexual maturity, but pullets on this ration laid the largest eggs. No harmful effects from the higher levels of protein were revealed in post-mortem examination.

The Utilisation of Feed by Chickens. 1. The Requirements for Growth. *W. A. Hendricks, M. A. Jull, and H. W. Titus. Poultry Sci.*, 1932, 11, 74-77. (*Bur. Animal Ind., U.S. Dept. Agric., Washington, D.C.*)—Fourteen groups of sex-linked day-old chicks were divided into 7 groups of cockerels and 7 groups of pullets and fed an all-mash diet of yellow corn 40 per cent., ground wheat 22 per cent., corn gluten meal 10 per cent., dried buttermilk 10 per cent., meat scraps (55 per cent.) 10 per cent., steamed bone meal 3 per cent., alfalfa leaf meal 2·5 per cent., yeast foam 2 per cent., and common salt 0·5 per cent. One group of each sex was fed *ad lib.*, the other groups 87·5 per cent., 75 per cent., 62·5 per cent., 50 per cent., and 25 per cent. of the food which chickens of the same age might be expected to consume. It was found that when allowance was made for maintenance the degree of utilisation of the food was independent of the level of feeding. One gram of feed produced approximately 0·35 g. body tissue in all the groups after allowance was made for maintenance. It is suggested that this method might be of value in determining the suitability of a food mixture for growth.

The Growth-promoting Values of Dried Buttermilk, Dried Skim Milk, and Dried Whey for Chicks. *F. E. Mussehl and C. W. Ackerson. Poultry Sci.*, 1932, 11, 69-73. (*Univ. Nebraska, Lincoln.*)—Over a period of eight weeks in two experiments, dried whey and dried buttermilk, when fed at the same protein level, proved of equal value for chick growth.

In an experiment with two groups of 30 chicks on the same basal ration, a dried skim-milk pen averaged 480 g. at the end of eight weeks, whilst a dried buttermilk pen averaged 588 g. In a repeat experiment with groups of 200 the figures were 639 g. for the dried buttermilk and 586 g. for the dried skim milk. The author concludes that there is significant difference in the value of dried buttermilk for growth in comparison with dried skim milk.

STATISTICS.

PRICES OF AGRICULTURAL PRODUCE, FEEDING STUFFS, AND FERTILISERS IN JUNE, JULY, AND AUGUST 1932.

LIVE STOCK: Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	June.			July.			August.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ..	54 11	49 0	..	55 6	49 6	..	54 3	48 3	..
Cross-bred (Shorthorn)	51 5	46 4	35 4	51 1	45 5	35 3	49 10	43 11	35 7
Galloway	51 0	44 8	..	47 2	42 8	..	47 3	42 4	..
Ayrshire	42 1	34 10	28 3	42 3	35 0	28 6	41 7	33 10	27 8
Blue Grey	..	..	..	..	..	..	..	..	..
Highland	..	..	..	..	..	..	..	..	..
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	15	7	..	14½	6½	..	14½	6	..
†SHEEP—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes. per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes. per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd. per lb. d.	Ewes. per lb. d.
Cheviot	9	7¼	6¾	8½	6¾	6½	7½	6½	5½
Half-bred	8¾	7¾	6½	8½	7½	6¼	7¾	7	5
Blackface	9	7¾	6¾	8½	7½	6½	7¾	6¾	5¾
Greyface	9¼	8¼	6½	8¾	7¾	6½	8	7¼	5½
Down Cross	9¼	8½	5¾	8¾	8	6	8¼	7	4½
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	7 7	7 1	..	7 3	6 10	..	7 6	7 0	..
Porkers	8 5	7 10	..	7 11	7 8	..	8 3	7 9	..

* Live weight. † Estimated dressed carcase weight.

Live Stock: Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	June. 1st Quality	June. 2nd Quality	June. 3rd Quality	July. 1st Quality	July. 2nd Quality	July. 3rd Quality	August. 1st Quality	August. 2nd Quality	August. 3rd Quality
STORE STOCK:—									
Cattle—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	16 13	13 13	9 8	16 11	13 9	11 15	16 4	12 17	10 15
Two-year-olds ..	22 14	17 16	13 10	21 8	17 5	14 8	20 12	16 6	14 5
Cross-bred (Shorthorn)									
Yearlings	15 6	12 0	8 14	14 17	12 5	10 8	14 14	11 19	10 2
Two-year-olds ..	20 12	16 6	12 2	19 4	15 19	13 5	19 6	15 8	14 0
Galloway:									
Yearlings	13 18	10 15	..	14 0	11 0	..	12 12	..	..
Two-year-olds ..	20 0	16 3	..	..	..	..	..	..	..
Ayrshire:									
Yearlings	11 11	10 3	..	10 19	..	..	..	..	..
Two-year-olds ..	15 3	13 5	..	..	..	..	..	..	..
Blue Grey:									
Yearlings	..	..	..	..	..	..	..	..	..
Two-year-olds ..	..	..	..	..	..	..	..	..	..
Highland:									
Yearlings	11 13	8 16	6 15	11 0	8 15	..	9 5	8 15	7 0
Two-year-olds ..	15 2	11 17	9 5	..	11 7	10 0	..	11 0	9 0
Three-year-olds ..	16 10	13 8	11 15	..	..	..	..	..	..
Dairy Cows—									
Ayrshire:									
In milk	23 12	16 9	11 18	24 18	17 18	12 0	24 16	17 5	12 5
Calvers	24 2	18 7	13 18	25 12	18 16	14 11	24 7	18 2	13 11
Shorthorn Cross:									
In milk	27 12	20 6	..	29 8	21 10	11 0	29 2	21 12	..
Calvers	26 10	18 7	13 9	26 10	18 5	16 3	26 15	18 19	15 14
Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ..	28 0	21 10	..	25 0	19 0	..	..	..	..
Half-bred Hoggs ..	39 5	31 10	..	32 0	20 6	..	..	..	..
Blackface Hoggs ..	26 7	20 2	15 2	16 0	12 0	..	..	..	..
Greyface Hoggs ..	31 3	25 0	22 3	28 7	21 7	..	..	..	..
Pigs—									
(6 to 10 weeks old)	23 11	14 4	..	20 4	12 3	..	20 8	12 7	..

Dead Meat: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	June.			July.			August.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb d.	per lb. d.	per lb. d.
Beef:—										
Home-fed—										
Bullock or Heifer ..	1	9¼	8⅜	9⅝	8½	8⅜	9⅝	8½	8¼	9¼
	2	8¾	..	8⅝	8	..	8⅝	8	..	8⅛
Bull	1	7¼	6¾	6½	6¾	6½	6⅜	6¾	6⅝	6¼
	2	6¼	6	6	6	..	6	6	6	6
Cow	1	6⅞	6	6⅛	6	5¾	5⅞	6	5¾	5¾
	2	6⅛	..	5⅛	5½	..	4⅞	5½	..	4¾
Irish—										
Bullock or Heifer ..	1	..	..	..	..	..	8⅞	..	..	8½
	2	..	..	..	..	..	8½	..	..	8⅛
Argentine Frozen—										
Hind Quarters ..	1	..	6¼	..	4	5⅝	..	4⅜	5¾	..
	2	..	4⅝	..	..	3¾	..	..	3¾	..
Fore „ ..	1	..	4⅜	..	3⅜	3½	..	3⅛	3½	..
	2	..	4	..	..	2⅝	..	..	2¾	..
Argentine Chilled—										
Hind Quarters ..	1	6¾	6½	6¼	6½	6	5½	6⅞	6¾	6⅝
	2	..	5¾	5½	..	4⅝	5	..	6	6¼
Fore „ ..	1	4½	4⅛	3⅞	3⅝	3⅛	3	3⅜	3¼	3⅛
	2	..	3¾	3⅝	..	2⅝	2¾	..	2¾	2⅞
Australian Frozen—										
Hind Quarters ..	1	..	..	5	..	..	4½	..	..	4
	2	..	..	..	..	..	..	..	..	..
Crops	1	..	..	4⅝	..	..	3⅝	..	..	3
	2	..	..	..	..	..	..	..	..	..
New Zealand Frozen—										
Hind Quarters ..	1	..	..	5⅛	..	..	4½	..	..	4⅛
	2	..	..	..	..	..	..	..	..	..
Fore „ ..	1	..	..	4½	..	..	3⅜	..	..	3
	2	..	..	..	..	..	..	..	..	..
Mutton:—										
Hoggs, Blackface ..	under 60 lb.	8¾	8¼	8⅜	8	8¼	8⅛	8	7¼	7
	60 lb. & over	8	..	7⅝	..	..	7⅝	7½	..	6⅝
„ Cross ..	under 60 lb.	8¾	8¼	8⅜	8	8¼	8⅛	8	7¼	7¼
	60 lb. & over	8	..	7⅝	..	..	7⅝	7½	..	6⅝
Ewes, Cheviot ..	1	..	6¼	7	..	5⅛	6¾	..	4	5¼
	2	..	..	6⅜	..	..	6¼	..	..	4⅝
„ Blackface ..	1	6¾	6¼	7	6	5⅛	6¾	5⅞	4	5¼
	2	6⅛	..	6⅜	5½	..	6¼	5⅜	..	4⅝
„ Cross	1	5¾	6¼	7	5	5⅛	6¾	4⅞	4⅛	5¼
	2	5	..	6⅜	..	..	6¼	4	..	4⅝
Argentine Frozen ..	1	..	..	3¾	..	..	3¾	..	..	3⅛
	2	..	..	..	..	..	..	..	..	..
Australian „ ..	1	..	4	3⅝	..	3¾	3½	..	4	3⅛
	2	..	3⅛	..	..	2¾	..	..	2½	..
New Zealand „ ..	1	..	..	3⅞	..	..	3⅝	..	..	3⅜
	2	..	..	3¼	..	..	3¼	..	..	2⅞
Lamb:—										
Home fed—	1	12	11¾	11½	..	9⅝	9½	9	8¼	8⅛
	2	..	..	8¾	..	..	8⅜	8½	..	7⅝
New Zealand Frozen	1	..	6⅞	6⅝	..	6½	6½	..	5¾	5¼
	2	..	6	6¼	..	5½	6¼	..	5⅜	5⅜
Australian „ ..	1	..	..	6¼	..	..	6¼	..	..	5⅝
	2	..	..	5¾	..	..	5⅞	..	..	5⅝
Argentine „ ..	1	..	..	5⅞	..	..	5¾	..	..	5¼
	2	..	..	..	..	..	..	..	..	4⅞

EGGS : Monthly Average Wholesale Prices at Aberdeen and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Market.	Description.	Quality.	June. s. d.	July. s. d.	August. s. d.
Aberdeen.	Country .. .. per doz.	1	0 10	1 2	1 3
		2	0 9	1 0	1 1
	Duck .. .. ,,	1	0 11	1 2	1 3
		2	0 10	1 0	1 2
Glasgow.	Country .. .. per doz.	1	1 1	1 5	1 5
		2	1 0	1 2	1 3
	Irish, Northern .. per 120	1	10 11	13 8	14 0
		2	9 9	12 7	13 1
	,, (Duck) ,,	1	8 4	10 1	10 10
	Irish Free State .. ,,	1	9 3	11 4	12 3
		2	8 5	10 10	11 9
	,, (Duck) ,,	1	7 11	9 10	10 5
	Belgian .. .. ,,	1	8 11	9 7	10 6
	Danish .. .. ,,	1	..	..	11 3
	Polish .. .. ,,	1	6 10	7 4	7 10
		2	6 4	..	6 11

PROVISIONS : Monthly Average Wholesale Prices at Glasgow.

Description.	Quality.	June. s. d.	July. s. d.	August. s. d.
Butter :				
Irish Creamery .. .. per cwt.	1	100 2	108 0	113 2
,, (unsalted) .. ,,	1	..	..	..
Australian .. .. ,,	1	100 5	106 6	109 7
Danish .. .. ,,	1	103 10	115 0	114 10
,, (unsalted) .. ,,	1	109 2	120 3	119 10
New Zealand .. .. ,,	1	101 7	108 3	113 2
,, (unsalted) .. ,,	1	105 10	113 3	116 7
Siberian .. .. ,,	1	98 0	97 3	96 2
Swedish .. .. ,,	1	102 2	110 0	108 10
Cheese :				
Cheddar .. .. ,,	1	78 5	73 0	74 7
,, ,,	2	72 0	66 0	67 2
Cheddar Loaf .. .. ,,	1	100 0	89 4	91 7
Dunlop .. .. ,,	1	67 2	71 0	74 5
,, ,,	2	65 2	67 9	72 5
Canadian .. .. ,,	1	77 3	62 0	63 10
New Zealand (Coloured) ,,	1	62 2	63 3	62 10
,, (White) .. ,,	1	63 7	64 6	66 2
Hams :				
Irish (Smoked) .. .. ,,	1	167 0	167 0	167 0
,, ,, ,,	2	154 0	154 6	156 5
American (Long Cut, Green) ,,	1	85 0	84 0	83 5
,, (Short Cut) .. ,,	1	71 10	83 9	77 5
Bacon :				
Ayrshire (Rolled) .. ,,	1	95 2	92 6	95 7
Irish (Green) .. .. ,,	1	96 0	92 3	96 0
,, (Dried or Smoked) ,,	1	102 0	98 0	102 5
,, (Long Clear) .. ,,	1	85 7	80 6	84 5
Wiltshire (Green) .. ,,	1	100 5	91 6	94 0
,, (Dried or Smoked) ,,	1	106 0	97 3	100 0
Danish Sides .. .. ,,	1	65 5	61 6	71 5
Dutch Green (Wiltshire Style) ,,	1	60 0	56 6	63 10
Polish Green ,, ,,	1	58 10	53 6	62 10

FRUIT AND VEGETABLES : Monthly Average Wholesale Prices at Glasgow.

(*Compiled from Returns received from the Department's Market Reporter.*)

DESCRIPTION.	per	QUALITY.	JUNE.	JULY.	AUGUST.
FRUIT :—					
Apples—	per		*s. d.*	*s. d.*	*s. d.*
British, Bramley Seedling	cwt.	1	..	..	22 0
Other Cooking ..	,,	1	..	..	20 0
Imported, American ..	case.*	1	..	13 0	14 2
,, ..	barrel.†	2	32 0	..	..
Australian ..	case.*	1	12 2	10 7	..
New Zealand	,, *	1	10 8	12 0	13 9
Pears, Californian ..	,, *	1	..	..	25 6
Australian ..	25 pears.	1	6 0	10 6	..
Gooseberries, British ..	lb.	1	0 2½	0 1¾	0 2¼
Strawberries, Scottish ..	,,	1	..	0 7¾	0 9
English ..	,,	1	0 11	0 6	..
Currants, Black	,,	1	..	0 7½	0 10¾
Red	,,	1	..	0 7	0 5¼
Raspberries	,,	1	..	0 7½	0 7½
Greengages, Imported ..	,,	1	..	..	0 6
Plums, British, Egg ..	,,	1	..	..	0 2¼
Monarch	,,	1	..	..	0 3¾
Prolific ..	,,	1	..	..	0 4
Victoria	,,	1	..	..	0 5
VEGETABLES :—					
Beans, Dwarf	,,	1	..	0 6	0 2
Beet	cwt.	1	14 0	‡5 3	7 0
Cabbage Scottish ..	dozen	1	1 6	1 6	1 2
Coleworts ..	,,	1	1 0	1 0	..
Red	,,	1	2 8	2 6	2 6
Carrots, British	cwt.	1	32 6	11 0	7 5
Dutch ..	dozen bunches.	1	7 8	3 9	..
Cauliflowers—					
Scottish	dozen.	1	..	3 0	2 2
Broccoli, Cornish ..	,,	1	5 0	3 0	..
Other British	,,	1	4 6	4 0	3 0
Dutch	,,	1	5 2	3 9	..
Celery	bunch.	1	..	..	2 7
Cucumber	dozen.	1	6 0	5 5	5 7
Leeks	dozen bunches.	1	2 9	..	5 7
Lettuce, Cos	dozen.	1	1 0	1 3	1 0
Cabbage ..	,,	1	1 8	0 11	1 1
Onions, *Spring*	bunch.	1	0 3	0 3¾	0 3½
Egyptian ..	cwt.	1	10 10	8 0	7 4
Dutch	bag.§	1	..	7 6	6 2
Valencia ..	case.‖	1	9 6	9 2	8 1
Parsley	cwt.	1	27 2	22 0	16 0
Parsnips	,,	1	8 0	..	..
Peas	,,	1	¶10 0	14 0	11 2
Radishes	dozen bunches.	1	1 5	1 4	1 2
Rhubarb	cwt.	1	2 0	2 6	3 6
Spinach	stone	1	4 0	4 0	4 0
Tomatoes—					
Scottish National Mark					
"A.A."	lb.	1	0 10¼	0 6¾	0 6½
Other Scottish ..	,,	1	0 10	0 6½	0 6
Channel Islands ..	,,	1	0 8¾	0 5½	0 4¾
Canary	,,	1	0 4	..	..
Dutch	,,	1	0 7¼	0 4¾	0 3¾
Turnips	cwt.	1	3 0	‡3 2	3 4
Vegetable Marrows ..	dozen.	1	..	4 6	4 0

* 40 lb. (approx.). ‡ dozen bunches. ‖ 9 stone (approx.).
† 9 stone (approx.). § 7½ stone (approx.). ¶ 3 stone (approx.).

POTATOES: Monthly Average Wholesale Prices at Aberdeen, Dundee Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Golden Wonder.	Late Varieties. Other Soils. Other.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
JUNE.							
Aberdeen, per ton	1	..	..	..	..	7 19 0	7 3 0
Dundee ,,	1	..	..	..	..	..	6 3 9
Edinburgh ,,	1	14 16 8	..	9 10 0	8 5 0	8 0 0	7 1 11
Glasgow ,,	1	..	..	..	..	8 8 0	6 15 6
JULY.							
Aberdeen ,,	1	9 0 0	..	..	..	5 7 6	..
Dundee ,,	1	6 13 4	..	..	..	4 15 0	..
Edinburgh ,,	1	5 18 9	..	..	..	..	..
Glasgow ,,	1	6 5 0	..	..	..	5 18 4	5 7 6
AUGUST.							
Aberdeen ,,	1	5 10 0	3 16 8	..	..	5 0 0	..
Dundee ,,	1	4 5 0	3 10 0	..	..	..	..
Edinburgh ,,	1	3 15 0	..	..	..	..	..
Glasgow ,,	1	3 12 6	..	..	..	..	..

ROOTS, HAY, STRAW, AND MOSS LITTER: Monthly Average Prices at Aberdeen, Dundee, Edinburgh, and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
JUNE.										
*Aberdeen, per ton	1	..	..	..	52 0	..	..	..	34 0	..
†Dundee.. ,,	1	..	..	..	90 0*a* 75 0*b*	..	61 0	..	61 0	55 0*c*
‖Edinburgh ,,	1	..	..	..	65 0*a* 60 6*b*	..	41 11	..	40 0	..
*a*Glasgow ,,	1	..	..	..	60 0	65 0	45 0	..	40 0	32 6*e*
JULY.										
*Aberdeen ,,	1	..	..	..	51 3	..	..	..	35 0	..
†Dundee.. ,,	1	..	..	..	90 0*a* 75 0*b*	..	60 0	..	60 0	55 0*c*
‖Edinburgh ,,	1	..	..	..	65 0*a* 60 0*b*	..	42 0	..	40 0	..
*a*Glasgow ,,	1	..	..	..	60 0	65 0	45 0	..	40 0	32 6*e*
AUGUST.										
*Aberdeen ,,	1	..	..	..	48 0	..	..	..	32 6	..
†Dundee.. ,,	1	..	..	..	84 6*a* 59 0*b*	..	60 0	..	60 0	51 0*d*
‖Edinburgh ,,	1	..	..	..	62 6*a* 49 0*b*	..	40 10	..	38 6	..
*a*Glasgow ,,	1	..	..	..	60 0	65 0	45 0	..	40 0	32 6*e*

* Loose, ex-farm.
† Baled straw, delivered.
‖ Bunched straw, delivered.
a Baled and delivered.
b Delivered loose.
c Dutch moss litter, delivered in town.
d ,, ,, ,, ex quay.
e Home moss litter, in 1½-cwt. bales.

Feeding Stuffs: Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	June. Glasgow.	June. Leith.	July. Glasgow.	July. Leith.	August. Glasgow.	August. Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	7 17 0	7 14 0	7 18 5	7 14 5	8 6 6	8 3 0
Foreign	7 19 0	..	7 16 11	..	7 19 0	..
Decort. Cotton Cake ..	8 5 0	..	7 18 5	..	7 14 3	..
Undecort. do., Egyptian (Home manufactured)—	4 19 3	4 19 6	5 0 8	5 1 3	5 14 6	5 15 0
Palmnut Kernel Cake ..	7 10 0	..	7 10 0	..	7 12 0	..
Coconut Cake	8 0 0	..	7 18 9	..	7 19 0	..
Groundnut Cake, undecort.—						
(37 % Oil and Albuminoids)	..	7 0 0	6 10 0	6 17 6	7 2 6	*6 12 0
(40 % do. do.)..	6 10 0	7 17 0	6 10 0	7 13 9	7 5 0	†8 0 0
Maize Germ Cake, Home ..	7 8 0	..	7 10 8	..	7 13 0	..
Maize Germ Meal	5 18 5	..	6 0 8	..	6 5 9	..
Rice Meal	5 11 6	..	5 2 6	..	5 11 9	..
Bean Meal	9 0 0	8 4 0	8 13 2	..	9 4 3	8 15 0
Barley Meal	8 4 0	7 10 0	7 13 5	..	7 14 3	..
Fish Meal	14 17 6	14 15 0	14 8 2	14 5 0	14 13 0	14 5 0
Maize Meal—						
Home manufactured ..	6 0 6	5 18 0	6 0 8	6 3 9	6 6 6	6 5 0
South African (Yellow) ..	5 13 11	5 10 0	5 15 4	5 18 9	6 3 6	6 0 0
(White)	..	..	6 0 0	..	6 7 6	..
Locust Bean Meal (Fine) ..	7 0 0	6 10 0	6 17 6	6 10 0	6 17 6	6 8 0
Maize Gluten Feed (Paisley)	5 13 9	..	5 13 9	..	5 15 3	..
Maize—						
River Plate	5 3 6	5 1 0	5 5 4	5 3 9	5 9 3	5 10 0
African (White, Flat) ..	6 2 6	..	6 2 6	..	6 5 0	..
Oats—						
Scottish	8 13 0	8 7 0	8 11 7	8 5 0	8 8 6	8 0 0
River Plate	6 16 0	6 5 8	6 11 7	6 2 6	6 11 9	6 2 6
Canadian, No. 2	8 2 9	8 0 0	8 0 8	..	8 1 3	..
Do. No. 3	7 18 0	..	7 15 8	..	7 18 0	..
Barley, Feeding (Home) ..	7 7 0	6 8 9	7 6 11	6 15 0	7 2 0	6 15 0
Wheat—						
Home	7 5 6	6 14 0	7 3 9	6 10 0	7 8 0	6 10 0
Do. (Poultry)	7 2 3	6 15 0	6 13 2	..	7 5 6	..
Imported	6 19 6	6 10 0	6 11 7	6 0 0	7 2 6	6 0 0
Middlings (Fine Thirds or Parings)	7 17 0	7 4 0	7 18 5	7 5 0	7 18 6	7 7 0
Sharps (Common Thirds)	6 3 6	6 4 10	5 19 8	5 18 9	6 5 6	6 7 0
Bran (Medium)	5 14 0	5 14 0	5 7 2	5 3 9	6 2 6	6 2 0
,, (Broad)	5 13 9	6 11 6	5 10 4	5 18 9	6 6 6	6 17 6
Malt Culms	5 8 6	5 13 9	5 6 3	..	5 11 0	..
Distillers' Grains (Mixed, Dried)	..	8 2 6	..	8 2 6	..	..
Brewers' Grains (Dried) ..	5 16 3	5 15 0	5 16 3	5 17 6	6 7 6	5 19 0
Distillers' Malt Grains (Dried)	7 5 0	..	7 5 0	..	7 10 6	..
Crushed Linseed	15 0 0	..	14 12 6	..	14 0 0	..
Locust Beans (Kibbled and Stoned)	6 0 0	5 18 4	5 19 8	6 0 0	5 18 6	5 19 0
Beans—						
China	8 7 0	8 1 3	7 18 9	8 0 0	8 9 0	8 0 0
Sicilian	8 12 6	..	..	..	..	..
English	8 10 0	..	..	..	..	..
Pease—						
Calcutta (White)	8 15 0	..	8 10 0	..	8 19 0	..
Karachi ,, ...	7 13 4	..	7 17 6	..	8 5 6	..
Russian ,, ...	8 12 6	..	..	..	..	..
Feeding Treacle	5 0 0	5 10 0	5 0 0	5 10 0	5 0 0	5 10 0
Linseed Oil, per gall. ..	0 3 0	..	0 3 0	..	0 3 0	..

39 per cent Oil, etc. † 50 per cent. Oil, etc.

FERTILISERS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	June. Glasgow.	June. Leith.	July. Glasgow.	July. Leith.	August. Glasgow.	August. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda *	N. 15·5	9 0 0	8 16 0	9 0 0	8 16 0	9 0 0	8 16 0
Nitrochalk * ..	N. 15·5	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0
Sulphate of Ammonia (Neutral and Granular) * ..	N. 20·6	6 1 0	5 17 0	5 5 0	5 5 0	5 5 0	5 5 0
Calcium Cyanamide †	N. 20.6	7 0 0	..	7 0 0	..	6 15 0	..
Superphosphate ..	P.A. 13·7	2 7 6	2 12 6	2 7 6	..	..	..
" ..	" 16·0	2 12 6	2 17 6	2 12 6	..	..	..
" ..	" 18·3	3 2 6	3 2 6	3 2 6	..	..	..
Ground Mineral Phosphate ‡ ..	P.A. 26	2 7 6	2 5 0	2 7 6	..	2 7 6	..
" " " ..	" 34	3 7 6	3 5 0	3 7 6	..	3 7 6	..
Potassic Mineral Phosphate	P.A. 18, Pot. 9	3 11 3	..	3 11 3	..	..	..
" " "	P.A. 18, Pot. 10	..	..	..	..	3 16 3	..
" " "	P.A. 20, Pot. 7·5	..	..	..	..	3 10 0	..
" " "	P.A. 21, Pot. 6	3 6 3	..	3 6 3	..	..	..
" " "	P.A. 21, Pot. 5	..	..	..	..	3 1 3	..
Kainit (in Bags) ..	Pot. 14	3 7 6	3 7 6	3 7 6	..	3 10 0	..
Potash Salts ..	Pot. 20	3 18 9	..	3 18 9	..	4 2 6	..
" " ..	" 30	5 7 6	5 7 6	5 7 6	..	5 11 3	..
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	10 5 0	10 5 0	10 5 0	..	10 5 0	..
Sulphate of Potash (on basis of 90 per cent purity)	Pot. 48·6	12 12 6	12 12 6	12 12 6	..	12 5 0	..
Steamed Bone Flour	N. 0·8, P.A. 28	6 0 0	..	6 0 0	..	6 0 0	..
Bone Meal (Indian)	N. 4, P.A. 20	7 0 0	7 5 0	7 0 0	..	7 0 0	..
Basic Slag § ..	P.A. 11	1 19 0	..	..	..	..	..
" " ..	" 12	2 1 6	..	..	..	..	..
" " ..	" 13	2 4 6	..	..	..	..	..
" " ..	" 14	2 7 0	2 0 6	2 4 0	..	2 3 0	..
" " ..	" 15	..	..	2 7 0	..	2 7 0	..
" " ..	" 15·75	2 11 0	2 5 6	2 10 3	..	2 10 0	..
" " ..	" 16·5	2 14 0	..	2 13 3	..	2 13 0	..
" " ..	" 17·5	2 18 0	..	2 16 6	..	2 16 0	..

Abbreviations:—N.=Nitrogen; P.A.=Phosphoric Acid; Pot.=Potash.

* Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

‡ At Glasgow—90 per cent. fineness through prescribed sieve; at Leith—85 to 90 per cent. fineness through standard 100-mesh sieve.

§ Glasgow:—F.o.r., in 6-ton lots, 80 per cent. citric soluble phosphate and 80 per cent. fineness; Leith:—Prices, F.o.r. Grangemouth, 5s. 6d. lower.

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